WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

UNEP

IPCC WGII
Fourth Assessment Report
Climate Change Impacts, Adaptation and Vulnerability

Expert Review of First Order Draft

Specific Comments

Chapter 15

December 5, 2005

Discussion of expert review comments and record keeping

IT IS RECOMMENDED THAT:

- AUTHORS BEGIN WORK ON THE COMMENTS IMMEDIATELY. SUBSTANTIVE COMMENTS NEED TO BE SEPARATED FROM NON-SUBSTANTIVE, AND THE TWO SHOULD BE TREATED DIFFERENTLY
- CONTACT IS MADE BETWEEN AUTHORS AND THEIR REVIEW EDITORS IN DECEMBER

Substantive comments

- The chapter writing team should discuss all substantive expert review comments, by email and/or at Merida.
- Substantive comments require full and proper consideration. The *Principles Governing IPCC Work* state that:
  - genuine controversies should be reflected adequately in the text of the Report and
  - it is the role of the Review Editors to advise the lead authors on how to handle contentious/controversial issues
- You must record the outcome of these discussions in this document, under the column 'Notes of the Writing Team'.

Non-substantive comments

- For non-substantive comments, a very brief entry should be made in the column 'Notes of the Writing Team'. The following terms are acceptable:
  - Addressed
  - Not applicable
  - Text removed
  - A tick to denote a comment has been addressed (somewhere on the document this should be stated)

General

- The record can be kept electronically, or with pen-and-paper.
- The document becomes part of the traceable account of the Working Group II Fourth Assessment. When completed to the satisfaction of the Review Editors, a copy should be returned to the TSU by the **28th February 2006**.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-0	A	0				**Co-chair and TSU comments** Length: this chapter is overlength by around 10 text pages, so some substantial trimming is required. This is especially the case since it is unfinished - Section 15.8 is incomplete. Executive Summary: this is a good Executive Summary, using bullet points to present the key findings of the chapter. Much of the first paragraph can be removed, although the statement that warming is likely to be greater at the Poles should be retained as background. The figures are beautiful - can the TSU please talk to your graphic artist? Contributing Authors: there are 8, which is perhaps enough, but the CLAs and LAs should ask themselves whether they have properly covered the field with the full range of expertise. The ZOD for this chapter showed a bias towards the Arctic and away from Antarctica - is there a proper balance this time, and could more CAs be used to help with this? Headings: the reduced-form headings are broadly followed. Section 15.8 is 'Key uncertainties' with nothing about Research Priorities - presumably research priorites will be added since this section is unfinished. Some summarizing/synthesisng figures could be added. There a few good examples in the FODs, such as Chapter 4 Figures 4.9 and 4.10. Fig. 4.9 is a map of the location of major impacts. Figure 4.10 is a sectoral burning embers diagram, but surely the concept could be applied at the regional scale. We want to include such material in the SPM and TS, but need the underlying evidence from the chapters. Please consider whether you could usefully contribute.	The author team has agreed a way forward to reduce the text to the required limit. Unfortunately, the requirement to cover two polar regions, with the sub-headings prescribed by the governments is limiting and means that some repetition is inevitable. The first paragraph is intended not to undermine the IPCC process but to put it in the correct context and in this respect it is required Our graphic artist is Peter Fretwell at BAS. We could usefully add a couple of CLAs from BAS on the Southern Ocean fisheries etc. We have tried hard to stick to the subject headings although these have meant that another level of headings is inevitable since under almost every heading we need to distinguish Arctic and Antarctic.

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						There is not a single table in this chapter. Problems of length could be addressed by moving material into tables - these tend to take up less space than text. Readers will find it easier to access key findings. It will help the authors to see what their key findings are, and will hopefully provide useful material for the SPM and Technical Summary. **(Jean Palutikof)**	I'm not sure that tables will help us (I do not agree that in general they take up less space), but we should scan for possibilities.
15-1	A	0				As a general comment, in a number of instances I worry about what sound like potentially overly glib disbursement of comments concerning impending change. THere are changes that are happening and are relatively short horizon/large impact that must be discussed, but perhaps step back from watering it down (or even confusing the relevant issues) by dealing with much lower level/longer term changes in the same breath. The fact that various systems respond at various rates must be accounted for when identifying what will be impacted for what reason. For example, a point already made concerned the change to northern ecosystems. These are directly and strongly threatened in the near-term by southern encroachment, and more weakly in the far term, by sea level rise. Perhaps the sea level rise aspect need not be discussed in that context, to help focus attention on ecosystem shift. The THC comment is another example. (David E Atkinson, University of Alaska Fairbanks)	The comment is noted and we will address each projection on a case-by-case basis TVC: simply a matter of wording
15-2	A	0				Generally well balanced and I see no major omissions. (Roger Barry, University of Colorado)	No response required
15-3	A	0				**This version is considerably improved in organziation and addresses the Southern Hemisphere in a more balanced manner**. Referencing to ACIA 2005 chapters and WG I sections has improved. However many statements still require proper referencing and some sections are too detailed.Other reviewers or editors can deal with imbalances.. My main focus is on permafrsot and therefore will confine most of my comments to relevant sections. Not all of my comments of 02-08-05 have been addressed and I will refer to several again. (Jerry Brown, International Permafrsot Association)	No direct response required, but spirit of criticism is noted. Permafrost related sections in the zero draft were incomplete, which is why it was not possible to address all previous comments appropriately. Reviewer, unlike TSU, indicates good balance between the Southern and Northern hemispheres.
15-4	A	0				As was done in the ACIA, most of the examples of Arctic change compare the present with the period about 30 year ago. The Arctic was emerging from an unusually cold period about then, so rates of change seem unusually high.	No direct response required, but spirit of criticism is noted.

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						Whenever it is possible, change should be measured from the mean state for the prior 100 years or more. (John Calder, National Oceanic and Atmospheric Administration)	IPCC assessment report is based on the available publications; most of the publications are focused on the changes that took place in the past several decades. Certainly, changes over larger time scales are interesting, as for example, "warming of the Arctic" that took place in 1930s. These, however, should be addressed in detail in WG-1 report, since our chapter is more focused on the impacts.
15-5	A	0				Mention is made to feedbacks at several places in the text but I feel more emphasis should be placed on this, these non-linear processes could be responsible for taking the polar environment to a tipping point beyond which there is no return and are equally applicable to the physical and biological regimes There is very little reference to the errors associated with the data, results and projections that are presented in this chapter - while it is impossible to provide numerical margins for every piece of evidence that is provided it might be worth having a section that acknowledges the difficulty in collecting data in polar regions, the sparse observational network, the relatively short period for which satellite data are available etc, and thus qualifying the results that are presented There appears to my mind to be a bias towards the marine and freshwater systems - I am not sure if this intentional or just the outcome of having so many different authors involved - to my mind these are not of such signifcantly greater importance to merit so much attention and there should be a more balanced approach in terms of terrestrial, cryospheric, atmospheric processes etc Clearly there are many more uncertainties pertaining to changes in the climate system, ocean system, ecosystem and cryospheric system that need to be addressed - and along with this the complexity of these systems, their close interaction and feedback, their sensitivity and potential to switch into a different state of (dis)equilibrium etc	Feedbacks and data limitations should be abd are addressed in detail in WG-1 report. Here we acknowledge the importance of these issues. The text was edited to better balance different systems and sectors and to evaluate uncertainties, to the extent possible. # This is a reasonable point and should be acted on . These sections are way-over the intended length and will need to be cut down. No direct response required, but spirit of criticism is noted.

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						(Fiona Cawkwell, University of Alberta)	
15-6	A	0				General Comments on the Chapter: The chapter is generally well written but it is packed with a lot of brief information with very little details. There also appears to be a major emphasis on biological, socio-economic and human aspects of the Arctic as opposed to the physical aspects. In particulat, there is an apparent lack of discussion about the physics of the change and instead too much discussion on qualitative and speculative material. Modeling results are referred to extensively but there is no description of how good the models are and to what extent we can believe them. There is indeed a page constraint that limits ability to provide specific and quantitative details but the text is full of repetition of many topics throughout the chapter. For example, the discussion about the changes in the percentage mixture of indigenuous and non-indigenuous people is repeated many times. I recommend reducing the repetition of similar topics in the various sections to a minimum and providing more details on the physical changes that has been occurring in the Arctic. It is after all, these physical changes that drives the biology that in turn drives the effects on humans and human health. (Josefino Comiso, NASA Goddard Space Flight Center)	The summary nature of the information is an unfortunate consequence of the page limit and the requirement for completeness. I don't think it can be avoided. Physical aspects and evaluation of the models are addressed in detail in WG-1 report. Text was checked for repetitions and modified appropriately. The physics of change are best covered by WGI and this chapter can only make reference to that body of work. The repetition of subject matter (e.g. indigenous peoples) is a function of the proscribed chapter headings and cannot be avoided. We thank the reviewer for these comments, but disagree that this is appropriate for WGII.
15-7	A	0				lack of descriptions on changes in physical oceanography in bi-polar oceans. It is better to add more Antarctic descriptions (Zhaoqian Dong, Polar Research Institute of China)	This subject matter is better and more completely covered by WGI
15-8	A	0				I think a paragraph needs to be dedicated to the important debate about the contribution of ozone-depleting gases to the Antarctic surface temperature trends. It is mentioned only in passing for the Peninsula trends in the case study (see my comment 3 above). (Peter Doran, University of Illinois at Chicago)	Physical aspects of climate change, including the ozone problem, are addressed in WG-1 report, this chapter is focused on the impacts.
15-9	A	0				Some inconsistency in the capitalisation or otherwise of both A/arctic and	Revisit this issue

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						A/antarctic (Julian Dowdeswell, University of Cambridge)	
15-10	A	0				There could be more use made of summarizing figures and maps. There is a lot of text and by necessity it is of a generalizing nature, the stuff of diagrams and maps. There have been some key results produced since the last report and these often have figures attached to them. For example, the results of the US/Canadian studies of mass balance of Greenland and Canadian ice masses have some visually grabbing graphics (maps) that would focus the whole section of changes in the polar ice masses. The one section on the cryosphere is closest to my expertise. There are some pretty large literature gaps in this section that should be filled. In fact I might recommend that they recruit someone like Roy Koerner to advise you on these sections. Just as an example, the mass balance studies of Canadian polar glaciers and ice caps since 1960 are a key resource and a figure of the mass balance changes in the Canadian Arctic from 1960 to present would be dramatic and act as a summary, as would a map of the US (Abdalati) study of changes in Greenland 1995-2000. By the way, Abdalati and Koerner also used the same aircraft to "do" the Canadian ice caps 1995 -2000 and have published a large paper on the subject, that seems to have been missed completely. There is also a similar paper on Svalbard. Both the latter and the Canadian Arctic ice caps show similar elevation changes to Greenland. It is this sort of oversight that leads me to suggest recruiting Koerner, of maybe Abdalati or Bob Thomas. As it is, there are too many holes in the literature coverage. Mention should also made to the effect of increasing amounts of meltwater reaching the bed of glaciers, increasing the velocity and hence increasing the calving rates of glaciers in all regions, most importantly in Greenland. This is to be a major center of an International IPY study. There is not much time dimension in the chapter. Good paleo records of temperature, accumulation and melt rate abound in both hemispheres but little use is made of them when talking about trends and changes. When talking about change one always has to have some idea of the "natural" variability and trends and place the modern in that context. Using inter-model differences as a measure of natural variability is not a good idea. While one has to be appreciative of people, who take their turns, picking up the	Some of these figures will appear in WGI and may be more appropriate in those chapters. This is covered in WGI chapters

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						heavy end of any given IPCC writing task, they should be careful not to over quote themselves.	
						When there are also evident gaps in the literature coverage, the tendency makes this reader a tiny bit cranky and could more importantly cause a general reader to be a bit dismissive.	
						Wrt review process, I don't like spread sheets, templates and other peoples' favorite software, so this WORD critique is what I can offer.	Agreed we should definitely not preferentially cite our own papers. LAs can we spot occurrences of this?
						There are some gaps here. I suggest you recruit an extra person or two to cover off some areas of expertise.	Agreed, but this chapter must be read in parallel with WGI which could cover much of the ground mentioned here.
						Additional References: Atkinson, D.E., R. Brown, B. Alt, T. Agnew, J. Bourgeois, M. Burgess, C. Duguay, G. Henry, S. Jeffers, R. Koerner, A.G. Lewkowicz, S. McCourt, H. Melling, M. Sharp, S. Smith, A. Walker, K. Wilson, S. Wolfe, M-k. Woo, K. Young, 2005: Canadian cryospheric response to an anomalous warm summer. Atmosphere-Ocean (accepted).	TSU issue! Possible
						W. Abdalati, 1 W. Krabill,2 E. Frederick,3 S. Manizade,3 C. Martin,3 J. Sonntag,3 R. Swift,3 R. Thomas,3 J. Yungel,3 and R. Koerner4 . 2004. Elevation changes of ice caps in the Canadian Arctic Archipelago. JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 109, F04007, doi:10.1029/2003JF000045.	Sounds interesting!
						Brown, R.D. and B.T. Alt (eds), 2001: The state of the Arctic cryosphere during the extreme warm summer of 1998: documenting cryospheric variability in the Canadian Arctic. Unpublished Report, Meteorological Service of Canada, Climate Research Branch, Downsview, Ontario, 33 pp.	Unpublished
						Burgess, D.O. and M.J.Sharp. 2004. Recent changes in areal extent of the Devon Ice Cap, Nunavut, Canada. Arctic, Antarctic and Alpine Research, 36 (2), 261-271.	
						Dowdeswell, J.A & 10 others (inc. R.M.Koerner). 1997.The mass balance of circum-Arctic glaciers and recent climate change. Quaternary Research, 48, p 1-14.	Possible

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						Fisher D A and Koerner R M. 2003. Holocene ice-core climate history:a multi-variable approach. In Global Change in The Holocene, eds MacKay A., Battarbee R. Birks J and Oldfield F. Published by Arnold 281-293. Fisher D A. 2002. High-resolution multiproxy climatic records from ice cores, tree rings, corals and documentary sources using eigenvector techniques and maps: assessment of recovered signal and errors. The Holocene 12,4, 401-419. Koerner R.M. and L. Lundgaard. 1995. Glaciers and Global Warming. Géographie physique et Quaternaire, Vol. 49, No. 3, p. 429-434. Koerner, R.M. Mass Balance of glaciers in the Queen Elizabeth Islands, Nunavut , Canada. Annals of Glaciology in press. Douglas Mair,David Burgess, and Martin Sharp, 2003, 37-Year Mass Balance of Devon Ice Cap, Nunavut, Canada, Determined by Shallow Ice Coring and Melt Modeling to determine the mass balance of Devon Ice Cap, Canada. . Geophysical Research Abstracts, Vol. 5, 10575, 2003 European Geophysical Society Paterson W S B. and Reeh N. 2001. Thinning of the ice sheet in Northwest Greenland over the last forty years. Nature. 414, 60-62. (David Fisher, Geological Survey of Canada)	Not impacts and adaptation
15-11	A	0				"Southern species constantly reach the Arctic but few become established". I feel this is an oversimplification. The inability of any incidentally established southern plant species to persist on the North Slope of Alaska is usually cited as the basis for this belief. But the main reason is that the Brooks Range serves to filter out accidental migrants while any species which do manage to germinate around Prudhoe Bay generally do not survive more than a year or two. However, elsewhere in subarctic and low arctic regions there are many documented cases of species establishment and persistence. With regard to plants, taxa can move into new areas as fast as roads or railways are built, and often along rivers. In North America and northern Russia southern ruderal plants have long established at the furthest north outposts of human settlement along the continental transportation network. Although they typically establish on disturbed or otherwise relatively bare mineral soils, some of these founder populations are then indeed maintained over many years, or even decades, with minimal additional disturbance. In the meantime they can establish viable propagule banks.This leaves them well poised to take	TVC: The reviewer is a little mixed up – I refer to Russian work, but I will add a few words and an extra reference.

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						advantage of new disturbance regimes or climate amelioration. Mediterranean weeds are now well established and spreading along roads and waste habitats in places as far north as Inuvik in Canada and southern Yamal Peninsula in West Siberia (Forbes 1995, 1997). References: Forbes, B.C. (1995) Effects of surface disturbance on the movement of native and exotic plants under a changing climate. In: T.V. Callaghan (ed.) Global Change and Arctic Terrestrial Ecosystems. Ecosystems Research Report 10, European Commission, Brussels, pp. 209-219; Forbes, B.C. (1997) Tundra disturbance studies. IV. Species establishment on anthropogenic primary surfaces, Yamal Peninsula, northwest Siberia, Russia. Polar Geography 21:79-100. (Bruce Forbes, University of Lapland)	
15-12	A	0				The environmental effects of Antarctic ozone depletion on biogeochemical cycles and terrestrial/marine ecosystem are not adequately analysed. In particular on my point of view the present knowledge (solar UV-B in conjunction with climatic stress) and present/future impacts (food chain) should be discuss (Massimo Frezzotti, ENEA)	# This needs to be answered. Do we have expert on UV? Do we need one?
15-13	A	0				In this chapter I would have liked to see a definition of the Arctic. If the Artic is defined as in the ACIA work then Northern Norway should have been included in the chapter. Also, there are few references to reports/scientific publications from the European Arctic (Svalbard) and Northern Norway. In the report I also would have liked to see more information presented from the Arctic Monitoring and Assessment Reports (AMAP) (i.e. from the Human Health report and the Pathway Report). The AMAP Pathway report deals with the biological responses to climate change and the effects of climate change on contaminant pathways. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	Firstly, definitions of the regions will be given elsewhere in the WG report. We refer to the definitions in TAR, but there is another consideration that we should talk in general terms as no-one has succeeded with this definition and it varies from model to model and data set to data set.
15-14	A	0				There is undue reliance, in the sections I have studied the most, on unpublished, and indeed, unsubmitted papers. There are 3 papers by Reist et al that are listed "in prep". What are we to make of these? What if they are rejected? (Konrad Gajewski, University of Ottawa)	Agreed, only “in press” papers will be included in the final chapter
15-15	A	0				I think it would be more useful to provide a comprehensive review of the literature, of which there is a lot, rather than a lot of speculative and unsubstantiated general statements, which may or may not occur. These statements may be right, but may not be, as they havent been studied.	No examples given, no direct response possible. Efforts have been made to include as much of the available literature as possible, however

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						(Konrad Gajewski, University of Ottawa)	IPCC is not just a literature review, thus expert opinions and hypothesis supported by the available publications are appropriate.
15-16	A	0				To follow up on the previous point, there is considerable danger here of raising speculative alarms. Considering the intense political scrutiny AR4 will receive, it is very important to find the right tone for poorly understood impacts. It would be much better to pepper the text with statements identifying gaps in understanding than in generating long lists of potential impacts that cannot be ranked in terms of probability or significance. Most of the chapter does not hit the mark here. There is a very fine line to tread between showing that progress is being made and admitting that much remains unknown. One idea to present this information would be to try and think in terms of what the key indicators might be: if parameter X changes by a certain amount, it will be an indicator of some important change to the ecosystem that would have major implications. This is in effect saying that we understand the system at this level (progress has been made), but we need to monitor certain things to better understand the impacts (much remains unknown, but we have some hope of figuring it out before it's too late. This concept of indicators also leads into adaptation well, because the indicators provide a mechanism for communities of stakeholders to gauge their response. (Philip Hill, Geological Survey of Canada)	There is always a danger of speculative alarms, particularly if the subject is not well studied. Most of the statements in the text are made with the indication of the level of certainty/uncertainty, which is the only way, in our view, to address the problem.
15-17	A	0				I realize that this is a first draft and to that extent it is quite rough around the edges. However, in my opinion, the chapter fails rather badly in its basic requirement, that is to clearly provide and update on understanding gained since the TAR. The chapter as a whole has a section on TAR but individual sections generally fail to provide clear reference points from the TAR by which progress can be assesed. This is primarily an issue of organization, but secondly of style. Each section would benefit from an opening section that summarizes the state of knowledge at the time of the TAR, perhaps as a short series of bullets, and then the remainder of the section could be written as a summary of recent work. Instead, most sections consist of very general reviews with a few recent references thrown in. This makes it very difficult to evaluate the level and significance of new understanding. In terms of style, many sections are far too "philosophic" and verge on being politically prescriptive. There may be a place for such statements but as presently included, they undermine the objectivity of the scientific findings. There are many references to pre-release versions of the Arctic Climate Impact	Restructuring the whole report in a way suggested by the reviewer so that each section begins with the bullets summarizing TAR findings is perhaps a good thing, however it is too late to discuss it. All chapters in the report are structured in a standardized way, this structure has been pre-set by government agreement and cannot be altered. Major findings of TAR are listed at the beginning of the chapter and are thus available for those who need a clear starting point. Referencing ACIA is far more effective than

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						Assessment science chapters. Hopefully, the science chapters will be officially released in final form before AR4 is finalized, but it still gives me some discomfort to see this synthesis report referenced rather than original peer-reviewed scientific papers on which it is based. It seems like something of a short cut approach. If the authors and editors feel that this is nevertheless acceptable, I would strongly urge them to explicitly explain, perhaps as part of section 15.1, the background and standards used for the ACIA. The chapter contains many discussions of how changes to the arctic system feeds back to the global climate system. While these are of course very valid points for AR4 in general and can be considered to be "impacts", I question whether they should be dealt with in this chapter. They are presumably dealt with in WG1 as part of the physical basis of climate change. The chapter would be better focused if it limited the content to impacts to ecosystems and human society. (Philip Hill, Geological Survey of Canada)	referencing all supporting publications individually, and it was a policy of the writing team. Some of the other reviewers indicated that more attention should be given to the feedbacks to the global climate system. We support the point that they should be addressed in detail in WG-1. In this chapter we acknowledge the importance of the mechanisms acting in the polar regions and discuss them at the level of detail necessary for understanding the impacts of the changing climate. We do not agree. The role of the polar regions within to Earth system is indeed an impact in the IPCC sense.
15-18	A	0				Concluding remarks: this draft is a start but I think that there are some serious issues of structure, presentation and content to be resolved. It is clear that impacts and adaptation research still has a long way to go and I believe that we are still trying to figure out a way to describe adaptation. It is very hard to write about adaptation because the very process involves a long-term analytic-deliberative process (National Research Council 1996. Understanding Risk: Informing Decisions in a Democratic Society. National Academy Press, Washington, DC.) so anything written at this stage tends to be prescriptive and hopelessly uninformed by the stakeholder viewpoint. I have suggested one possible approach to this problem, that of attempting to set up and talk (or write) against "performance" indicators based on the conceptual level	This is a good point, and we have taken great care not to pre-empt or speak for the peoples of the Arctic in our assessment of likely impacts. Generally speaking, adaptation is not our main domain and should be addressed to WG-3.

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						analysis of impacts that is generally possible in any one domain. I'd be happy to discuss this idea further if it would be helpful. (Philip Hill, Geological Survey of Canada)	This approach is too specific for use here.
15-19	A	0				A major issue that is missing from this chapter is that of threshold changes. People expect responses to climatic change will be gradual, however since so much of the environment is near 0C, threshold changes are common and dramatic. These result from degradation of permafrost, wildfires, changes in snow or rainfall regimes and other types of disturbance. Overpeck, J. T. M. Sturm, J. A. Francis, D. K. Perovich, M. C. Serreze, R. Benner, E. C. Carmack, F. S. Chapin III, S. C. Gerlach, L. C. Hamilton, L. D. Hinzman, M. Holland, H. P. Huntington, J. R. Key, A. H. Lloyd, G. M. MacDonald, J. McFadden, D. Noone, T. D. Prowse, P. Schlosser, and C. Vörösmarty. 2005. Arctic System on Trajectory to New, Seasonally Ice-Free State. 86(34): 309, 312–313. 23 August 2005. (Larry Hinzman, University of Alaska Fairbanks)	The idea of threshold-driven vs gradual changes is discussed in the chapter. Particularly, the water phase transition threshold is discussed in association with the freshwater resources; threshold-driven changes are discussed in association with the impacts of thawing permafrost, changing vegetation and other environmental factors on fluvial geomorphology. Reference will be added, which journal, though?
15-20	A	0				Why is there no section on "Projected changes in the biosphere"? Cf. Section 15.3 (page 1 and 16). I think such a section should be included in the chapter (Annika Hofgaard, Norwegian Institute for Nature Research)	TVC: there is a lot of text on this topic embedded in the chapter, but the section headings have been prescribed and cannot be altered – no change.
15-21	A	0				Hansen's group showed the importance of soot which can affect the climate of the arctic regions. But I could not find the term "soot" or "black carbon" in this chapter. Why? (Kiminori Itoh, Yokohama National University)	OA - Because soot has strong effect on the physical processes, particularly , radiation balance, and not only in the polar regions, and these are addressed in WG-1 report. TVC – also Maggan for snow-permafrost interaction I agree with the comment and I also think this is an important issue. Bøggild had an interesting poster on this at ICARP 2. All posters are on the DPC homepage so we could look it up. We will also look at Vlassova's manuscript
15-22	A	0				This Chapter has improved substantially since the zero-order draft. Clearly, a lot of effort has been made to develop the text and to research the different topics. I have only one major concern at this stage, which is no doubt a concern of the authors- namely how to reduce the length of the chapter to 25 pages? Given that some	# Very appropriate comment, changes have been made, as suggested. TVC: Great – we should not be asked to make

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						references will be the same as other Chapters, it still means that up to 20 pages have to be deleted. I have suggested sections that could be reduced or deleted under specific comments. However, my general feeling is the sections on aquatic biology and human interactions, however relevant, could be substantially pruned. The terrestrial biology section has already undergone a substantial reduction which is possible because of the recent ACIA 2004 publication. Can a similar cut-back and cross-referencing be made with the two sections above and with the hydrology sections ? I look forward to seeing the second-order draft. (Robert Jefferies, University of Toronto)	more cut-backs
15-23	A	0				Given the length constraints ch15 summarises the informationand current research trends very well and is well balanced in the subject matter. There is one exception, a large amount of information and data is contained in the Arctic Human Development Report AHDR which was sponsored by Arctic Council. This was almost a companion volume to ACIA whichj is the basis of Ch 15. We have been trying to promote the integration of the two reports rather than separate consideration because although ACIA has made strides in the integration of human activities it still leaves many gaps which AHDR addresses. Studies by some of the co-authors of AHDR are quoted but it would be invaluable to refer to AHDR specifically.specifically. THROUGHOUT CHAPTER NO SPECIFIC REFERENCE TO ARCTIC HUMAN DEVELOPMENT REPORT CRITICAL PARALLEL VOLUME TO ACIA ON HUMAN CONDITION IN THE ARCTIC (Peter Johnson, University of Ottawa)	# Reference was added
15-24	A	0				The sections on human impacts are far too wordy and in most cases redundant and in most of the sections say essentially the same thing (external cultural influences have made it more difficult for native peoples to adapt to climate change). This report would be much more readable if the human impacts sections where cut by at least 50%. Be consistent in document and use either C0-2 or carbon dioxide but not both. (Ian Joughin, Applied physics Lab, University of Washington)	Little of this material was discussed in the TAR and so we feel justified in making it an significant issue in this assessment – however cuts will be sought. Redundancies have been removed. We think we can use both CO-2 and carbon dioxide,

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							why not?
15-25	A	0				The chapter addresses regions of the world that are already undergoing substantial changes in climatic conditions and is experiencing impacts of these changes that affect the integrity of marine and terrestrial ecosystems and the well-being of arctic residents. As such, the polar regions –and the Arctic in particular- deserve special attention in the Forth Assessment Report of IPCC. The chapter is overall well written (neglecting some typographical errors and a few unclear expressions, which we were asked to ignore) and follows the outline for the chapter as given in Appendix 3 of the Guidance Notes. As far as I can see, the chapter quotes all literature relevant to the issues addressed and largely follows the suggestion to use only literature published after 1999. My concerns with this chapter are of a more general nature and may not be reconcilable at this stage. In any case, I would like the authors to consider the following points: a) There seems to be an imbalance in the space devoted to arctic versus antarctic issues, i.e., more space is being used to address questions related to arctic climate change compared to the Antarctic coverage of these subjects. b) This largely reflects the general differences between the two polar regions and the greater importance that we usually attach to the Arctic. This is mainly due to the fact that the circumpolar North is (albeit sparsely) populated by native and non-native communities, whereas Antarctica is only home to a very few people. Moreover, while terrestrial ecosystems and their services are almost insignificant in Antarctica, the terrestrial ecosystems and terrestrial natural resources play a major role (e.g., the hydrocarbon deposits, timber) in the Arctic. c) Thus, I find it somewhat questionable to treat both regions in one chapter, despite the obvious similarities they do share. But again, this is probably not to be changed anymore. d) Given the somewhat greater weight that is being attached to the Arctic in this chapter, it also suffers from the fact that a quite comprehensive assessment of climate change and its impacts is just being published, i.e., the ACIA Report. The	a) Efforts have been made to balance the representation of the Arctic and Antarctic, and some reviewers noted that they were more successful than in TAR. Has something been missed in the Antarctic that needs to be noted? b) We agree with these considerations, as does the text of the chapter. c) This is not to be changed anymore, as the reviewer suggests. d) There is a lot of interceptions with the ACIA report, which is not surprising. Since Polar regions have been included into the

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						Report is a quite extensive account of climate change and its impacts in the circumpolar North. Thus many of the findings reported here can also be found in the ACIA Report, making the present chapter somewhat obsolete. e) In order to reconcile this and to distinguish this chapter from the ACIA Report more clearly, the authors should strive to emphasize the comparisons between the polar regions (and the Arctic in particular) and other regions of the world more prominently, thus utilizing the strength of the global approach that the IPCC is applying versus the regional approach ACIA has taken. Once again, I realize that these may be suggestions that are not feasible anymore. But anybody who knows the ACIA Report may also notice the substantial overlap with the material contained in this chapter. Point 2 Despite the fact that this section reviews the TAR findings, already at this point the ACIA Report may be introduced, as this represents an even more comprehensive assessment of climate change in the Arctic compared to the polar chapter in the TAR. Point 4 While neglecting a seasonal snow cover might have been permissive in former assessments, the ongoing change in climate, particularly on the Antarctic Peninsula and the sub-Antarctic islands has already led to something like a seasonal snow cover, at least as far as summer melting is concerned. Point 5 This section focuses somewhat too heavily on only 10% of the population in the Arctic. While understandable, addressing adaptation strategies of indigenous people almost exclusively is nevertheless inappropriate. Some more room should be given to the non-indigenous part of the population (the sentence on p. 38, lines 32-33 does not make much sense to me). Point 6 This section on “economic activity and infrastructure in the Arctic” addresses almost exclusively the impacts of climate change on permafrost and their repercussions for arctic residents and infrastructure. However, there are quite a few other sectors that need to be addressed in this context, most notably changes in terrestrial ecosystem and implications for forestry as well as climate impacts on marine ecosystems and their consequences for the fisheries industries. In my view these sectors are of greater importance compared to the permafrost issues addressed here. The problem of increased transport activities along the Northern Sea Route or along	IPCC report, we have to address the key regional impacts, even if they have already been discussed in ACIA. References are given, where necessary. e) The chapter is focused on the polar regions, and this is given. Point 2 # text changed. Point 4 # Which action is expected? Point 5 # -The representation is proportionate with the literature; there is particular interest in these populations as the most vulnerable; and interest in these pops from a political perspective as well. We will try to balance this out as much as possible where appropriate but a weighting towards Indigenous populations will persist to some extent as this is also what exists in the literature, challenging the assessments on non-ind pops. Will add short intro statement to this effect as well for the Chapter Point 6 # Accepted.

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						the North American coast and associated contamination of marine ecosystems is only slightly introduced. (Manfred Lange, University of Muenster)	
15-26	A	0				This is a very good first oder draft on the assessment of future impacts and adaptation in polar regions. The chapter title (Climate Change) is obviously not the correct one. (Peter Lemke, Alfred Wegener Institute)	No action needed, the chapter title is “Polar regions”.
15-27	A	0				The chapter authors should be urged to avoid using vague words like "may", "could" and "might" and instead indicate level of likelihood or confidence using the IPCC lexicon. (Michael MacCracken, Climate Institute)	# will be checked.
15-28	A	0				Chapter 15: Overall comment: The material that is here looks very good. I was, however, a bit surprised not to see more coverage on: (a) the changing state of the Greenland Ice Sheet, even though that is covered mainly in the WG I report (and just to note that they do not seem to yet have a consistent picture of the expectation in chapters 5 and 10); and (b) the non-Indigenous residents of the Arctic, in that they make up something like 90% of the population--the chapter seems very heavily ecosystem oriented, and there is good reason for extensive coverage on this (the text actually has more than the table of contents indicates, so perhaps it is a question of making the set of information more focused, at least in the Executive Summary), but I would have thought there should be more coverage of the economic and other impacts on non-Indigenous people (though I realize there may be relatively little information on this). (Michael MacCracken, Climate Institute)	# CF will address the question about the non-indigenous population.
15-29	A	0				I am pleased with the way that the chapter is coming together overall. However, I am concerned that no references are given to the potential impacts of methane hydrates on climate change. I believe that the two mentions of methane hydrates (page 16, lines 43-47, and page 44, lines 13-14) should at least mention the references in No. 3 below. The vast global quantity of methane hydrates points to the importance of further discussion. (David Malcolm, Arctic Energy Alliance)	This is largely the issue for the WG-1
15-30	A	0				There is need for a serious rewriting of this chapter. There are numerous grammatical errors (some point out below). Also need to check the references - several are "in prep". The coverage of items needs to be reviewed for geographical bias of the authors	Any grammatical errors will be caught in the proofing stage. The in prep papers will either be in press or removed. We believe that the geographical bias

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						knowledge. (Gordon McBean, University of Western Ontario)	generally represents the bias in research progress and improved understanding that has been achieved since the TAR.
15-31	A	0				**I have 3 general comments on Chapter 15 (Polar Regions). First, the chapter is well written and comprehensive. It builds on the recent Arctic Climate Impact Assessment Report and provides an appropriate balance between Arctic and Antarctic issues.**	Noted
						My second general comment is that the definition of the terrestrial extent of the Arctic is rather fuzzy. A lot of the literature being summarized is from research that has been conducted on the collar of tundra ecosystems encircling the Arctic Ocean. But at other times in the chapter it seems that the boreal forest is brought into the discussion. This has been a general problem in almost all assessments of the "Arctic". My preference would be to have the boreal forest biome considered as part of the Arctic because the southern limit of the boreal forest biome roughly coincides with the southern boundary of permafrost and most of the watershed that empties into the Arctic Ocean is in the boreal forest. A lot of the critical changes that are happening are where permafrost is near thawing, i.e., in discontinuous permafrost regions of boreal forest.	The definition of the Arctic follows the one in TAR, and to be consistent with the previous reports it should not be changed. Moreover, since Arctic and Antarctic have already been defined in TAR, we should not do it here again.
						On the physical side permafrost and hydrology have been discussed as if they include the boreal forest, but the discussion of terrestrial ecology and human dimensions are limited to the tundra biome. Ecology issues that I think need more discussion are fire, insects, forest management and economics, peatland ecology, and carbon dynamics to name a few off the top of my head. I don't know how much of a re-write it would take to get these issues into this chapter, but I fear that they won't be adequately dealt with in the other chapters.	TVC: we include the tundra and forest tundra but cannot include the boreal forest per se. I will see if there is space to include extra words on boreal forest problems such as fire.
						My third general comment is that the issue of natural vs. anthropogenic change is not adequately discussed. It is quickly glossed over on page 7, lines 10 - 12, with the reference to Polyakov et al. (2002). It is a major challenge to the scientific community to sort out the degree to which changes are associated with multiple decadal low frequency "natural" variation vs. the result of anthropogenically caused climate change.	OA - The discussion about the nature (anthropogenic vs natural) climate change is appropriate in WG-1 report. Here we address the impacts of the changing climate in the polar regions, and thus the problem of attribution of the climatic changes to any specific factor or group of factors is beyond

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						Also, permafrost thaw and glacial retreat in Alaska has been occurring since the end of the little Ice Age (since the 1700s or so). These issues need some more attention in this chapter and at least need to be mentioned and put into context in the executive summary and the summary of knowledge sections of the chapter. (Anthony McGuire, University of Alaska Fairbanks)	the scope of the chapter, as well as WG-2 report. The time frame used in the chapter includes historic variations of the Arctic, including permafrost and glaciers, and projections to the future. There is not too much we can say about the variations of permafrost and glaciers following the little Ice Age in this chapter, since this is largely the domain of WG-1, and more importantly, since they are not considered as impacts, which are the main focus of the chapter.
15-32	A	0				The chapter is an excellent overview and reference work to the present situation in the Arctic and the Antarctic. (Hans Meltofte, National Environmental Research Institute)	Noted
15-33	A	0				Use of Jargon / specialist language This chapter has a diverse authorship and will have a diverse audience. Perhaps it should be considered whether the following should be explained or replaced by less specialist language? “freshets” – will this be generally understood? “recruitment” – ditto? “lentic system” “lotic system” – P22 Line 16. Difficult to understand from context. (Tavi Murray, University of Wales Swansea)	# The text was changed to the extent possible TVC to change recruitment (if he used it)
15-34	A	0				(1) On a whole the chapter is well written and informative, densely packed with information. (2) In several spots, sentences are incomplete (words left out) in such a way that it is difficult to know the intended meaning. (3) Some topics are discussed two or more times. This is likely because of the outline that was imposed on the authors and so perhaps is unavoidable, although eliminating the repetition could help shorten the text. (4) The chapter does a very nice job in indicating both positive and negative consequences of anticipated continued warming. However, it woud be useful also to have a statement to the effect that much of the chapter is based on the assumption of further warming and that the reason for this is that continued warming is projected by the overwhelming majority of model simulations. (Claire Parkinson, NASA Goddard Space Flight Center)	The text has been checked for redundancies once again and modified accordingly. We did not consider any scenario leading to colder climate, which is in accord with the IPCC climatic projections. There is no need to make such a statement, since this is implicit in all IPCC writings.
15-35	A	0				General Comments on Chapter 15: 1) Authors are more focused on Canadian and American Arctic than on European.	(1) The chapter text is built upon the available

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						2) The marine climate is discussed less than terrestrial and atmospheric climatic processes. 3) In the structure of this chapter there are recurrences of the same information, for example the estimation warming in the Antarctic Peninsula is given in 15.2.1 and 15.2.2 (Vladimir Pavlov, Norwegian Polar Institute)	publications, including those for European Arctic. (2) We do not discuss the climate, which is done in WG-1 report. The chapter is focused on the impacts of climate change, both on marine and terrestrial systems. Is any of the impacts on marine systems missed? (3) Redundancies have been removed.
15-36	A	0				This is a wide-ranging chapter, with detail on physical, social and ecological aspects of change. It improves on the previous IPCC position in updating the current position and providing more detailed analyses of future predictions from current models. I particularly liked the examples in boxes, and would like to have seen one on krill in the southern ocean, or the extreme sensitivity of Antarctic marine species to a warming environment. On the negative side the chapter is a little loose. There are many sentences saying this or that is likely. We should try to be a bit more quantitative by saying YY% of models predict an increase of XX. The chapter is clearly a draft and needs work to tidy up some sentences that are either not English or make no sense. As a comment on the whole chapter/volume – I could not find an assessment of effects on the deep sea. Although we know less about this zone it does cover a larger area than any other on earth, and some assessment of changes and prospects for the deep sea should be included. (Lloyd Peck, British Antarctic Survey)	Physical aspects of changes in the climate system, including changes in the deep sea, fall into the domain of WG-1 and are not addressed in the chapter.
15-37	A	0				First, the chapter is a very good summary, putting together nearly all of the important literature that I knew of, and a lot more that I didn't, together in a concise and emphatic way. It was nice to see that waffle words were kept under control, and yet at the same time the balance between the good, or the mild, and the more unpleasant aspects of climate change was presented well. There is a hefty emphasis on biological effects - and I think some roll- back here should be considered, to favor a slightly greater fraction of the discussion focussing on climate. I still don't have a clear idea of what global climate trends might be expected from a loss of summer Arctic sea ice, for example - surely there must be some research on that. (I'm aware of a couple of studies that link drought in the SW North America with a warm, low-ice Arctic, but that's about it).	Reviewer's suggestions are more appropriate for WG-1 writing team, we do not see what can we do in response in our chapter.

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						(Ted Scambos, University of Colorado)	
15-38	A	0				I found the quality and style of this Chapter very uneven. Some sections come across as authoritative summaries of current knowledge that focus on key issues of unquestioned significance. Others come across as rather uncritical and disorganised collections of statements and conclusions with no coherent logic. I found it very difficult to derive much of value from the latter sections and I find it hard to see how they would be of much benefit to policy makers. I have the sense that there is a strong need for a thorough general edit by the Co-ordinating authors to weed out material that lacks substance or is poorly integrated. This should help to bring the chapter within its proposed page limit. (Martin Sharp, University of Alberta)	The text was edited, many of the problems mentioned by the reviewer were fixed.
15-39	A	0				OVERALL COMMENT: Overall, Chapter 15 is well-written and throrough. It covers most of recent developments in polar climate change since the Third Assessment Report, with one glaring omission: The recent discoveries of glacier-flow accelerations in Antarctic, apparently triggered by the disintegrations of small ice shelves and their associated "buttressing effect" on upstream ice. This discovery represents a major new develpment/uncertainty in predictions of sea level rise in this century. Only in the Case Study 15.6.3, pp. 40-41 is this important recent discovery mentioned. It is glaringly absent from the earlier sections on Antarctic change. I'm sure this is the case only because of the relative newness of the discovery - it is very significant and must be included in the Fourth Assessment. The remainder of my comments are very minor in nature, my compliments to the authors. (Laurence C. Smith, University of California, Los Angeles (UCLA))	As noted by the reviewer, it is in the text.
15-40	A	0				General Comment - Parts of the chapter have relied heavily on the results from ACIA. This is fine but it has perhaps meant that more recent publications have not been included in the chapter. Some suggestions for recent publications that could be added have been made. A number of papers in preparation have been referred to in the text. Should paper not be at least accepted for publication before being referred to in this document? (Sharon Smith, Geological Survey of Canada)	All problematic references will be removed at a final stage. Yes, we are updating it and many very recent important publications are included that were not available in the ACIA. One noticeable in prep paper is the one by Christensen et al. and it will be withdrawn if it isn't published by the next IPCC deadline.
15-41	A	0				The chapter feels tentative, while the literature appears more definitive. For example the Executive Summary deserves more clarity especially in those areas	

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						where the literature is reaching consensus. Missing in the chapter: reference to pest infestations such as the spruce bark beetle. Missing in the chapter: reference to slope instability (slumping, slides, etc.) due to changes in permafrost and forest fire events. Missing in the chapter: Indigenous voice. (John Streicker, Yukon College)	# we need to add something suggested by the reviewer.
1	A	0				The text could be shortened substantially without losing too much important information. The chapter makes good reading, but my impression is that it contains too much detail that readers can readily find in the voluminous references if they want it. (Robert Thomas, EG&G Services)	The text was shortened.
15-43	A	0				Being an expert in physical climate I have concentrated on climate issues dicussed in this chapter. I think, for the first draft, the chapter is in a reasonably good shape. Terminology: There is somewhat arbitrary use of the terms "forecast", "prediction" and "projection" starting from the very first page of the Exective summary, where all of these terms can be found with a dominance of "prediction". This terminological mixture decays but survives through further sections. For future climate simulations with GCMs, it is better to use "projections", rather than "prediction" (see the IPCC TAR Glossary). I think additional pictures of key climate trends can be very useful for the Report readers, for instance, both hemispheric temperature and pressure distributions from Turner et al., 2005. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Consistency in using the terminology has been checked. Due to strict page limits no figures showing climatic trends and similar climatic information was added. These should be represented in WG-1
15-44	A	0				This is a much better chapter in all aspects than the first draft. While the first draft was quite weak on the marine system there is almost too much of it now in the three separate sections. There seems to be a lot of repetition between the various sections of the chapter but perhaps this is not such a bad thing? Coverage of economic impacts of climate change is brief and disappointing. This is where the most severe impacts are likely to occur, at least in the Arctic (Gunter Weller, University of Alaska)	Discussion on the economic impacts has been expanded.
15-45	A	0				These chapters provide a useful summary of previous studies. Their contents, figures and tables are appropriate and I found no major points that need to be rewritten. However, these chapters do contain many repeating sentences and phrases. I think it needs to be carefully edited so that there are no longer word for word repeating sentences, and that it is also grammatically correct and succinct.	Repetitions have been removed to the extent possible

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						(Kenji Yoshikawa, University of Alaska)	
15-46	A	1	0			Following are the references alluded to in the comments. Most are available from my home page at http://members.cox.net/igoklany/. I'll also be happy to send hard copies, if requested: 1. Goklany, IM. 1995. "Strategies to Enhance Adaptability: Technological Change, Economic Growth and Free Trade." Climatic Change 30: 427-449. 2. Goklany, IM. 1999. "Richer is More Resilient: Dealing With Climate Change and More Urgent Environmental Problems." In R. Bailey, ed., Earth Report 2000, Revisiting the True State of the Planet (New York, NY: McGraw-Hill), pp. 155-187. 3. Goklany, IM. 2000. "Potential Consequences of Increasing Atmospheric CO2 Concentration Compared to Other Environmental Problems." Technology 7S: 189-213. 4. Goklany, IM. 2005b. "Integrated Strategies to Reduce Vulnerability and Advance Adaptation, Mitigation, and Sustainable Development," accepted by Mitigation and Adaptation Strategies for Global Change. . (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Only papers that have been published after 2001 and that address the issues of climate change impacts will be considered in this chapter.
15-47	A	1	1	44	20	There is a general imbalance with respect to where the work geographically has been made, i.e. there are very few references from the EuroArctic (Jan-Gunnar Winther, Norwegian Polar Institute)	Efforts have been made to include all publications containing essentially new results obtained since TAR, i.e. after 2001.
15-48	A	1	1	44	20	Many of the reported results are similar to the ones stemming from the ACIA report. Larger emphasis should be put on referencing the ACIA report or/and seeking to reference more recent work (Jan-Gunnar Winther, Norwegian Polar Institute)	ACIA report is cited in several places in the chapter
15-49	A	1	4	1	4	The title of "Climate Change" should change into "Polar regions (Arctic and Antarctic)" (Zhaoqian Dong, Polar Research Institute of China)	I don't understand where this comment comes from. The title is "Polar Regions"
15-50	A	1	4	1	4	Is the chapter title ok? (Annika Hofgaard, Norwegian Institute for Nature Research)	I don't understand where this comment comes from. The title is "Polar Regions"
15-51	A	1	4	1	4	It seems the chapter title should be "Polar Regions (Arctic and Antarctic)" rather than "Climate Change". (Claire Parkinson, NASA Goddard Space Flight Center)	I don't understand where this comment comes from. The title is "Polar Regions"
15-52	A	1	4	1	4	It is proposed to substitute the current heading "climate change" with the heading as agreed "Polar Regions (Arctic and Antarctic)". (Klaus Radunsky, Umweltbundesamt GmbH)	I don't understand where this comment comes from. The title is "Polar Regions"
15-53	A	1	4			What is the correct name of this Chapter?	I don't understand where this comment comes

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						(Vladimir Romanovsky, University of Alaska Fairbanks)	from. The title is "Polar Regions"
15-54	A	1	4			Chapter title is wrong (Robert Thomas, EG&G Services)	I don't understand where this comment comes from. The title is "Polar Regions"
15-55	A	3	0			General comments on the executive summary: The summary is quite comprehensive and briefly describe the content of the entire chapter. However, in the key findings, quatitative results and their significance should be provided. For example, it would be good if while saying that the discharge of Eurasian rivers has increased since the 1930s, they also provide the numerical fractional increase. This way, those who do not have a lot of time and read only the executive summary will be better informed. (Josefino Comiso, NASA Goddard Space Flight Center)	Noted
15-56	A	3	0	4		I believe that an explicit statement about the Greenland ice sheet and its likely contribution to sea level rise would be appropriate in this section. (Tavi Murray, University of Wales Swansea)	Comment rejected, it should be in WG-1
15-57	A	3	0			Key findings should include the recent breakup of ice shelves, and thinning of others (Robert Thomas, EG&G Services)	In the executive summary we have a more general statement about the decreasing glacier volume.
15-58	A	3	0	4		The summary of key findings is excellent and appears to cover all observed and likely future changes and impactsimpacts (Gunter Weller, University of Alaska)	Noted
15-59	A	3	1			The executive summary is extensive and covers all the major issues. In the list of key findings there are some repetetion concerning the ecosystem response to climate change (points 2, 3, 10). Also the order of the items in the list could be reordered as ii) common issues for the both polar regions ii) terrestial Arctic iii) the Arctic Ocean iv) the Southern Ocean and Antarctic continent (Jari Haapala, Finnish Institute of Marine Research)	Noted, text was modified
15-60	A	3	1			Generally, clearer conlusions are given in the summary than in the text throughout the chapter (Annika Hofgaard, Norwegian Institute for Nature Research)	No response
15-61	A	3	1	4	31	Executive Summary: This section really needs a careful edit to make it clearer and more direct, and so a number of suggested changes are included below. I also think that the ACIA set of findings is somewhat more comprehensive and should be consulted as part of the revision process. (Michael MacCracken, Climate Institute)	Noted. This comment is conflicting with that of Gunter Weller above. ACIA report certainly has different set of findings, since the report itself addresses the wider range of problems in the Arctic.
15-62	A	3	1			Executive Summary: ACIA lists coastal community exposure to storms as a key finding. Is this worthy of inclusion as a key finding in this chapter? (Marybeth Long Martello, Harvard University)	No, this was known well before the ACIA report was published, see, for example, IPCC TAR, WG-2, Chapter 16

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15-63	A	3	3			Unclear what processes are involved. (Roger Barry, University of Colorado)	The text was changed.
15-64	A	3	3	3	3	Specific Comments Start here: delete the word "future." This is not necessary since it is by the word "forecast" in the following phrase. (Josefino Comiso, NASA Goddard Space Flight Center)	Done
15-65	A	3	3	3	3	Delete "future" as redundant. (Michael MacCracken, Climate Institute)	Done
15-66	A	3	3	15	15	Is "prediction" the best word choice here? Or would projection be more accurate? "Predict" and "prediction" are used elsewhere in the chapter, sometimes to refer to what models do and provide. I would suggest that "project" and "projection" also be considered as replacements in these instances. (Marybeth Long Martello, Harvard University)	Noted
15-67	A	3	3	13	13	Is "predict" the best word choice here? Or would project be more accurate? (Marybeth Long Martello, Harvard University)	Repeated
15-68	A	3	3	12	13	Chapter states "means the impact of climate change on these systems is still difficult to predict." Yet, ACIA and IPCC have given some fairly detailed ideas about what these impacts are likely to be. So could the above statement be modified slightly to say "means the specific impacts of climate change on these systems is still difficult to predict." (Marybeth Long Martello, Harvard University)	Noted, too general to cause any specific action
15-69	A	3	3	27	27	Change "increasing" to "increasingly" (Marybeth Long Martello, Harvard University)	Comment rejected
15-70	A	3	3	5	5	Authors may wish to reconsider the phrase "increasing use of Traditional Knowledge" as it is vague as to who is increasing their use of Traditional Knowledge - scientists, indigenous peoples, others? Also, some indigenous knowledge holders may object to the idea that their knowledge can be extracted by others and employed in an instrumental way. Suggested alternatives are: "increasing recognition and understanding of Traditional Knowledge by climate researchers" OR "increasing recognition of and reliance on Traditional Knowledge by climate researchers" (Marybeth Long Martello, Harvard University)	Comment rejected
15-71	A	3	3	3	4	These changes were observed over the last 5 years? (Sharon Smith, Geological Survey of Canada)	Yes
15-72	A	3	3	3	4	This statement seems a bit too loud. I don't think climate change and climate-induced change "forecasts"are verifiable at the time scales like the 6-year period between the TAR and AR4. In other words, this statement implicitly presumes several-year predictability of the climate system, which I think is debatable,	Noted, text changed.

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						particularly for high latitudes. It might be better to state that there have been new evidences supporting TAR conclusions, or that the assessment has retained its validity, or something like that. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	
15-73	A	3	4	3	4	replace the phrase "This Validation.." with "The ability to make accurate forecast…" I think that the models have a long way to go before we can consider them validated. (Josefino Comiso, NASA Goddard Space Flight Center)	Noted, text changed
15-74	A	3	4	3	4	I would suggest changing "have now been observed and documented" to "are now being observed and have recently been summarized in the uniquely detailed Arctic assessment (ACIA, 2005)." Note here that I use ACIA, 2005 (so the full volume) rather than the overview report, for that is where the extensive documentation is; I understand the book will be out November, 2005. I brought the latter phrase up from lines 10-11 as it seemed to work better here--and the sentence from lines 6-11 needed to be shortened. (Michael MacCracken, Climate Institute)	Noted, text changed
15-75	A	3	5			The statement "… increasing use of Traditional Knowledge, has improved our ability to project future changes in physical and biological systems" doesn't have any support in the following text of the Chapter (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted, text changed
15-76	A	3	6			revise use of term "appear to indicate" - implies lack of clarity of what models show (Gordon McBean, University of Western Ontario)	Noted, text changed
15-77	A	3	6	3	7	Model projections don't "appear" to indicate, they "do" indicate that the dramatic warming will continue. (John Streicker, Yukon College)	Noted, text changed
15-78	A	3	7	3	7	Replace "dramatic recent rates" with "the amplified rates" as this is a science report. (Michael MacCracken, Climate Institute)	Noted.
15-79	A	3	8	3	8	replace the word "impacts" with "magnitude" (Josefino Comiso, NASA Goddard Space Flight Center)	Rejected
15-80	A	3	8	3	9	How is impact being defined here? In terms of impacts on natural systems? Human systems? This is important for comparison to other regions of the world which have higher population densities (Sharon Smith, Geological Survey of Canada)	Definitions of key terms used in IPCC report are given elsewhere.
15-81	A	3	9	3	11	Replace "will exceed … (ACIA 2004)" with "will be more pervasive than for many other regions on Earth." It is really hard to know how one would measure impacts	Noted, text changed

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						and so justify saying exceed--other areas are larger, have more people, etc, so costs may be greater elsewhere, for example. But in Arctic the impacts will likely affect a greater fraction of the ecological and social systems, so pervasive seems a better word choice. (Michael MacCracken, Climate Institute)	
15-82	A	3	9			insert "those in" after "exceed" for clarity (Gordon McBean, University of Western Ontario)	Text was changed
15-83	A	3	10	3	11	I thnk, the reference should be made not to the the ACIA-2004 (summary), but to the entire ACIA scientific report (2005, hopefully), which is indeed "a uniquely detailed assessment", unlike the summary for general public and policy makers. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Noted
15-84	A	3	11	3	11	why not use 2005 (Jerry Brown, International Permafrsot Association)	Comment misplaced
15-85	A	3	11			...in biological, especially anthropogenic systems, and (Robert Jefferies, University of Toronto)	Comment rejected
15-86	A	3	11	3	11	Replace "However" by "Because of" as this is not a contradictory thought. (Michael MacCracken, Climate Institute)	Noted
15-87	A	3	12	3	12	rewrite as follows: "..that the latter are subject to additional and cascading stresses, means that the impact of climate change on …" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted, text changed
15-88	A	3	12	3	13	Change "means the impact" to simply "the impacts, and change "is still" to "remains" (Michael MacCracken, Climate Institute)	Noted, text changed
15-89	A	3	13			Why is the evidence of ongoing change from the rest of the Antarctic continent not spelled out? In many other cases where evidence is equally ‘less conclusive' and predictions of likely impacts are similarly difficult, there have been no inhibitions to project - or to express expectations about - future developments. (Hans H.J. Labohm, Netherlands Institute of International Relations 'Clingendael')	Comment rejected
15-90	A	3	14	3	16	Seems inconsistent: "Dramatic impacts are expected…evidence of ongoing change less conclusive…prediction of impacts difficult…". How can dramatic impacts be expected when prediction of impacts are difficult? This is also discussed on page 9, line 7. (Arne Instanes, OPTICONSULT Consulting Engineers)	Comment rejected. As stated in the text, prediction of impacts is difficult in regions other than those where dramatic impacts are expected
15-91	A	3	14	3	15	On line 14, change "but" to "although" and on next line delete "here" (Michael MacCracken, Climate Institute)	Noted
15-92	A	3	15	3	15	insert "a" at the end of the line to read "...a prediction…"	Noted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Josefino Comiso, NASA Goddard Space Flight Center)	
15-93	A	3	16			.... impacts is even more difficult. (Robert Jefferies, University of Toronto)	Noted
15-94	A	3	18			Executive Summary Key Findings; use of bold or italics to emphasise key issues would be helpful (Fiona Cawkwell, University of Alberta)	TSU/editorial issue
15-95	A	3	18			Executive Summary Key Findings; these bullet points should be regrouped so that like topics are together e.g. climate, sea-ice, vegetation etc (Fiona Cawkwell, University of Alberta)	Noted
15-96	A	3	18			Executive Summary Key Findings; given that this is the section that is going to be most widely read by experts and non-experts it would be helpful to quote values for some of these changes e.g. rapid rates of warming, how far has tree line moved, how much has river discharge increased, which species are migrating poleward etc (Fiona Cawkwell, University of Alberta)	TVC: for discussion – it is doubtful if there is space for this information as there are not single, agreed figures for these statistics. DGV – I agree, there is rarely a simple figure that can be given without lots of explanation and qualification.
15-97	A	3	18			Executive Summary Key Findings; a confidence scale (as in the TAR) using asterisks would be helpful to indicate uncertainty to readers who are unfamiliar with elements of these changes (Fiona Cawkwell, University of Alberta)	Noted, confidence levels added
15-98	A	3	18			In this section, make sure to compare with ACIA (2004) key findings to make sure same scope is covered. I did not see adequate mention of: links between ozone/UV/human health; cultural impacts; changes in access with less sea ice--and reduced access due to permafrost melting; etc. (Michael MacCracken, Climate Institute)	We do not feel that the ACIA key findings need be reflected in full since this is an independent assessment of important findings
15-99	A	3	18			The chapter should include a brief discussion of the rationale for addressing the Arctic and Antarctic together in a single chapter. This discussion should briefly note relevant environmental conditions in these two regions and their role in the global climate system. Some of this rationale can be found in the list of key findings on page 3 and elsewhere in the chapter. However, a more explicit statement of this rationale would make the chapter more compelling. (Marybeth Long Martello, Harvard University)	The authors of the chapter cannot provide the rationale, which was developed in the pre-report scooping phase undertaken by governments. The chapters authors are not entirely convinced that the approach is the optimum one.
15-100	A	3	18			The conclusions, as put in the bullet points of the Executive Summary, are rather general and quantitative. It would be good to have some more quantitative statements if possible. Tables have been built for the SPM which show impacts related to incremental global mean temperature changes, and to times in the future under different SRES scenarios. Chapter 4 Table 4.5 lists impacts against temperature changes, and Chapter 11 Table 11.11 lists impacts at future dates under	Noted

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						SRES. Please have a look at these and see if you could do something similar. (Jean Palutikof, Hadley Centre)	
15-101	A	3	19	3	19	replace "show" with "are observed, including" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted
15-102	A	3	19	3	23	The changes in polar areas have been dramatically regional. For example the warming in Siberia and Canadian Western Arctic has been much greater than in the eastern Arctic and Greenland. Mention of regionalism is in order here. (David Fisher, Geological Survey of Canada)	Noted, we have covered that in the first bullet.
15-103	A	3	19			Comments on 1st bullet. Noting that some areas in the Arctic and the Antarctic have shown the most rapid rates of warming, etc., seems to be cherry-picking data. I would recommend providing trends that are integrated over the entire Arctic and, separately, over the entire Antarctic. Moreover, since we are talking about climate change, the current situation should be viewed in a context long enough for the reader to be convinced that the variations that we see currently are outside the range of natural variability. This would mean looking, wherever possible, at variations over past centuries, if not longer. That would help answer questions regarding whether current changes are within the bounds of natural variability. Why is this important? First, it obviously sheds light on the issue as to the likelihood of current changes being due to non-natural factors. Second, if changes of similar magnitude occurred in the past, this begs the question as to how -- and how well -- human and natural communities and species responded and coped with them. See, also comments below on Section 15.2.1. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Rejected, see the previous reviewer's comment, which is more in accord with our standpoint. In TAR, Chapter 16, as well as In many parts of FAR Ch. 15 text there are notes that the recent changes are likely to exceed the level of natural variability.
15-104	A	3	19	3	23	It should be mentioned and specified that areas with no change or even cooling do exist (Annika Hofgaard, Norwegian Institute for Nature Research)	This is implicit in the first bullet.
15-105	A	3	19	3	20	Change "show profound regional differences both within" to "are becoming evident in the Arctic. These impacts exhibit significant regional differences within" (Michael MacCracken, Climate Institute)	Rejected, essential point is regionalism of changes.
15-106	A	3	19	4	31	The verbs used in this section need consistency and definitions. It is difficult to know whether there are actual differences among "will", "may", is likely to", is expected to". (James McCarthy, Harvard University)	Noted
15-107	A	3	20	3	20	insert "some" to read "However, some areas…" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted

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15-108	A	3	20			However on a global scale,.... (Robert Jefferies, University of Toronto)	Noted
15-109	A	3	20	3	20	Delete "However"--this is not a contradictory statement. (Michael MacCracken, Climate Institute)	Noted
15-110	A	3	20			Line 20 and remaining parts of the report: there is inconstancy in use of capital initials in Arctic and Antarctic as adjective. (Hans Meltofte, National Environmental Research Institute)	Noted
15-111	A	3	22	3	22	rewrite to read "The impacts of currently observed and future climate change…" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted
15-112	A	3	22			'hotspots' probably not a good term to use in a generic sense when discussing climate change (Julian Dowdeswell, University of Cambridge)	Comment rejected, the term ‘hotspots’ is well established
15-113	A	3	22	3	23	This illustrates the previous point. The first, and therefore highest impact, key finding gets sidetracked by the issue of global feedbacks. (Philip Hill, Geological Survey of Canada)	Noted
15-114	A	3	22	3	23	Change to read "polar regions are likely to excite feedbacks that, over time, will have significant global consequences." Really try to avoid the ill-defined word "may" and use the IPCC lexicon. (Michael MacCracken, Climate Institute)	Noted
15-115	A	3	22	3	23	"may produce feedbacks that in time, have globally significant consequences." This statement seems weak to me. From the literature it is clear that the feedback is already globally significant (e.g. Finding 2 of the ACIA). Examples include albedo, ocean currents, sea level, migratory species etc. I think the bigger question is whether the feedback mechanisms are becoming self-sustaining. Some recent literature is suggesting this is the case although I'm not sure that there's consensus as yet. (John Streicker, Yukon College)	Noted. The currently existing text is in accord with the ACIA finding. Self-sustainability is not addressed in the chapter, though.
15-116	A	3	23			in time, will have globally... (Robert Jefferies, University of Toronto)	Noted
15-117	A	3	24	3	26	On line 24, delete "There has been a measured" and start with "Changes in the composition"; on nest line, change "as a" to "have been observed in" and then later say "especially in response to increasing …)" (Michael MacCracken, Climate Institute)	This editorial comment is rejected
15-118	A	3	25			the statement of considerable changes in composition with reference to the sub-Antarctic islands is actually not well documented, except in the context of possible climate interactions with the direct human impacts associated with assisted transport and accidental/deliberate introduction of non-indigenous species (see	There is a mention of a measured changes rather than considerable changes.

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						Frenot, Y., Chown, S.L., Whinam, J., Selkirk, P., Convey, P., Skotnicki, M. & Bergstrom, D. (2005) Biological invasions in the Antarctic: extent, impacts and implications. Biological Reviews 80, 45-72, for a detailed and comprehensive review). (Peter Convey, British Antarctic Survey)	
15-119	A	3	26			It is not clear whether the "change" applies to the change in composition or climate change. Clarification of what "likely" means is also needed. There will be more climate change but does that mean the composition may or may not change. (Gordon McBean, University of Western Ontario)	Change applies to composition and range of plants and animals, as stated in the text
15-120	A	3	26			Executive summary: What Temperature? Air or water? Or both? Instead of "changing precipitation" note whether it is: decreasing or increasing. (Vladimir Pavlov, Norwegian Polar Institute)	Comment reject. Air and water temperature changes are interrelated; precipitation changes are patterned, but all these details are marginal to the main statement
15-121	A	3	27	3	27	rewrite as follows: "…produce increasingly more complex responses…" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted
15-122	A	3	27			It is not clear what kind of disturbances on the Antarctic Peninsula were meant (Vladimir Romanovsky, University of Alaska Fairbanks)	More specific term is inappropriate here; the message in this bullet is clear.
15-123	A	3	28			Comment on 3rd bullet. Considering that there have been other warming episodes in the past, how do the current position in tree line compare with what it has been in the past? Similary, how do current changes in the ranges and abundances of various species compare with past changes? (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Unclear which action is expected. How this comment relates to executive summary?
15-124	A	3	28			shrublands (Robert Jefferies, University of Toronto)	question unclear.
15-125	A	3	28			Needs reference to definition of 'greenness' (Peter Johnson, University of Ottawa)	TVC to fix
15-126	A	3	28	3	31	To make the statement more direct, change opening to read "The observed increase …" and delete "that" on line 28, then on line 20 change to read "biological productivity, leading to a change in the ranges of species (e.g., …)" and on line 30 delete "some" and change to read "changes in the position of the tree-line and of the ranges ..." (Michael MacCracken, Climate Institute)	Noted, text changed
15-127	A	3	28	3	32	Some comment on whether rate of climate change exceeds adaptive capacity would seem appropriate. (Gordon McBean, University of Western Ontario)	TVC to fix although this is already covered elsewhere
15-128	A	3	28	3	29	There is no proof yet that the documented increase in greenness of the Arctic represents an increase in biological productivity	there are estimates of productivity derived in similar ways to greenness

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						(Vladimir Romanovsky, University of Alaska Fairbanks)	
15-129	A	3	30			Executive summary: What are changes in position of the tree-line and what changes in ranges and abundance of some animal species? Did they increase or decrease (e.g. abundance)? (Vladimir Pavlov, Norwegian Polar Institute)	TVC to fix
15-130	A	3	32			Discharge …. Shows (Julian Dowdeswell, University of Cambridge)	Noted, text changed
15-131	A	3	32	3	32	Change "vegetation zone relocation" to "poleward and upward shifts in vegetation zones" (Michael MacCracken, Climate Institute)	TVC: OK, will do
15-132	A	3	33	3	33	insert "significant" to read "show a significant increase since the 1930s.." (Josefino Comiso, NASA Goddard Space Flight Center)	Rejected
15-133	A	3	34	3	34	replace "although" with "while" (Josefino Comiso, NASA Goddard Space Flight Center)	Noted
15-134	A	3	34			..precipitation, although changes to cryospheric processes (Robert Jefferies, University of Toronto)	Noted, text changed
15-135	A	3	35	3	35	permafrost THAWS not MELTS; needs to be corrected throughout (Jerry Brown, International Permafrsot Association)	Noted, text changed
15-136	A	3	35			Executive summary: “modifying flow pathways” is not clear. What does this mean? Seasonality of what? (Vladimir Pavlov, Norwegian Polar Institute)	Noted, text changed
15-137	A	3	35			Here and in several other places instead of "permafrost melt" should be "permafrost thaw" (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted, text changed
15-138	A	3	35	3	35	permafrost thaw is a better term than melt (Sharon Smith, Geological Survey of Canada)	Noted, text changed
15-139	A	3	36	3	37	Change to "as is predicted" and "and fluvial morphology, and on near-shore …" (Michael MacCracken, Climate Institute)	Disagree
15-140	A	3	37	3	38	freshwater, riparian, fluvialmophology and sea ice formation and potentially thermohaline circulation are likely to be profound. I suggest adding freshwater affecting sea ice formation to this sentence. (David Barber, University of Manitoba)	Rejected.
15-141	A	3	37	3	37	insert "land cover" after morphololgy, (Jerry Brown, International Permafrsot Association)	Rejected, since here we are focused on the effects of discharge changes, and these do not cause noticeable land cover changes
15-142	A	3	38			Change "are likely to be" to "could be". (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Noted, text changed

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15-143	A	3	38			..are likely to be profound. (This is vague in an Executive Summary, it requires specific information or cross referencing) (Robert Jefferies, University of Toronto)	Noted, text changed
15-144	A	3	39	3	41	The retreat of sea ice in the Arctic has progressively increased with the minimum on record being that of 2005. This has resulted in increased open water for navigation, changes in coastal ecology/production, increases in coastal erosion and changes to the sea ice-cloud albedo feedback mechanism. (David Barber, University of Manitoba)	Noted, text changed
15-145	A	3	39	3	41	rewrite as follows: A rapid decline in the Arctic perennial ice cover (i.e., ice during summer minima) during the last 26 years has been observed from satellite data. Near term continuation of this decline is suggested by observed warming trends in the region and the ice-albedo feedback effect and would lead to profound changes including changes in ocean circulation, increased open water for navigation, changes in coastal ecology/production, and increased coastal erosion. (Josefino Comiso, NASA Goddard Space Flight Center)	Noted, text changed
15-146	A	3	39			Recent research has shown that winter sea ice is also decreasing (Larry Hinzman, University of Alaska Fairbanks)	Noted, text changed
15-147	A	3	39	3	41	Increased coastal erosion caused by increased open water is debatable. Most of the wave energy is released in the surf/beach zone anyway. Sea level rise is much more important than just more open water. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted, text changed
15-148	A	3	39	3	40	Change to read "The accelerating retreat…" and delete the parenthetical phrase as then being duplicative. (Michael MacCracken, Climate Institute)	Editorial comment is rejected
15-149	A	3	40	3	41	Executive summary: What are changes in coastal ecology/production? Increasing or decreasing? (Vladimir Pavlov, Norwegian Polar Institute)	TVC – this is a gap in the writing team TVC cannot fix this alone. DGV – this may be an important issue but has not emerged as one of the key findings of the chapter deliberations and so is not included in the executive summary.
15-150	A	3	41	3	41	incresed coastal erorison, This cause if still not well established, intuitively makes sense. If true, needs reference to an authoriative, peer-reviewed paper to substantiate. (Jerry Brown, International Permafrsot Association)	Noted, text changed
15-151	A	3	41	3	41	insert "over land" to read "freshwater ice over land" The subject is different and should be set up as another bullet (Josefino Comiso, NASA Goddard Space Flight Center)	Disagree

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15-152	A	3	41	3	43	Delete "also" on line 41 and change "but" to "although" on line 43. (Michael MacCracken, Climate Institute)	Noted, text changed
15-153	A	3	41			Is there any proof of increased coastal erosion? (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted, text changed
15-154	A	3	42	3	43	Mention should also be made to security and sovreignty issues, which are of particular consequence to Canada with the potential opening up of an ice-free North-West passage sea route (Fiona Cawkwell, University of Alberta)	Noted, text changed
15-155	A	3	43			Change "but cultural" to "while current". First, lifestyles are always cultural. Second, lifestyles will change, even if it's not due to climate change. It used to be that they were much more invariant, but now with the advent of technology -- e.g., TV, internet, phones, movies, etc. -- such changes are inevitable. In fact, they occurred before people became aware of climate change. Third, the "but" suggests a negative connotation to a change in lifestyle. Although, many (or even most) indigenous people might subscribe to this notion, it is not clear that for the majority of the Arctic people (90% of whom are non-indigenous) would necessarily have a problem with that. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Noted, text changed
15-156	A	3	43			Cultural lifestyles? Ballet? Music? Sculpture? Theatre? (Hans H.J. Labohm, Netherlands Institute of International Relations 'Clingendael')	Noted, text changed
15-157	A	3	43			also affects ice-dependent animals adversely (John Streicker, Yukon College)	Noted, text changed
15-158	A	3	44			The recent results of Hansen and the reports at Exeter meeting about the possile irreversible melt of the Greenland ice sheet would seem apprpropriate here. (Gordon McBean, University of Western Ontario)	Noted, text changed
15-159	A	3	45	3	45	I would suggest changing "predictions agree" to "analyses and model results indicate". Also, change "this loss" to "these losses"--might change line 44 to be "Glacier volumes"--or maybe say "Total Glacier volume" and keep line 45 as is. (Michael MacCracken, Climate Institute)	Rejected
15-160	A	3	45	3	47	Change "clear" to "significant" and in list on line 46 add "availability of water resources" in that glacial melt streams are being altered and in some regions are likely to disappear. (Michael MacCracken, Climate Institute)	Noted, text changed
15-161	A	3	45	3	46	Executive summary: I suggest to add “impact on ocean thermohaline structure” (Vladimir Pavlov, Norwegian Polar Institute)	Rejected, this is for WG-1
15-162	A	3	45	3	46	also affects ocean circulation (John Streicker, Yukon College)	Rejected, this is for WG-1

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15-163	A	3	48			Move this bullet up one to keep sea-ice-related issues together. (Ian Joughin, Applied physics Lab, University of Washington)	Rejected, this is Arctic vs Antarctic split.
15-164	A	3	48	4	2	There are two statements mixed up in one sentence, which should be separated. One is concerned with the mid-20th Century reduction of sea ice extent. The other is on the recent decline of the krill abundance, which is connected to a recent reduction of sea ice extent. The latter statement is to my knowledge only true for the Southwest Atlantic. There is no large-scale sea ice retreat observed recently. (Peter Lemke, Alfred Wegener Institute)	Noted, text changed
15-165	A	3	48	4	2	Delete "Although" and end the sentence at "doubt" Then make the rest of this point a new bullet--it is really a separate thought. (Michael MacCracken, Climate Institute)	Noted, text changed
15-166	A	3	49			The proposed decline of Antarctic sea ice extent during mid-1950s and early 1970s proposed by de la Mare (1997) probably is too high. However, other studies pointed out a change in environmental condition link to sea ice extent (eg, king and Harangozo, 1998, Ann. Glaciol. 27; Curran et al. Science, 2003, Murphy et al., Deep Sea res 1995), ice front of floating glaciers (Frezzotti, Ant. Sci. 1997; Frezzotti et al., Ann Glaciol. 1998) and biota (Ainley et al., Pol. Res. 2005) for the same time period. Regional variability in Antarctic sea ice-extent is large and it makes climatic trends difficult to determine, however on my opinion a change in sea ice-ocean environmental condition has occurred during mid-1950s and early 1970s, but it is difficult to establish. I would suggest rephrasing the point (Massimo Frezzotti, ENEA)	This is actually a difficult area, the de la Marie work was alone in appearing to show widespread retreat, and so with this study compromised, they is very little evidence to prove or disprove a widespread retreat. We do not disagree with the reviewers general feeling but there is little evidence to cite, and so we are not confident including such discussions.
15-167	A	3	50			What is "salp"? (Robert Thomas, EG&G Services)	Noted, text changed
15-168	A	3		4		the order of the summary bullets should be reconsidered to make a more logical list - e.g, linking bullet 3 with bullet 10 and bullet 1 with the latter part of bullet 12 (Gordon McBean, University of Western Ontario)	Noted, done
15-169	A	4	0	6		Summary of knowledge assessed in TAR The structure of this section seems odd. Statements that are now longer strictly accurate or have been called into doubt are presented as statements that, if the report is dipped into, may be taken as current knowledge. For example: P5 Line 9. Now commented as inaccurate. P6 Line 4. “the small risk that the West Antarctic and Greenland ice sheets retreat in coming centuries…”. I would say that current evidence suggests that the risk that the Greenland ice sheet retreats in the coming centuries is high rather than small.	This statement is intended to reflect the statemements made in the TAR, and not to discuss them in detail – can this be emphasised? This comment is probably sufficient Agreed

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						P6 Line 8-9 At the current time I would also mentioning changes in albedo and carbon storage at this point. (Tavi Murray, University of Wales Swansea)	
15-170	A	4	0			missing bullet discussing human health, security? (John Streicker, Yukon College)	These two issues have been added to the existing bullets
15-171	A	4	2			Executive summary :with higher consequences for higher predators. Since marine mammals and seabirds are included in the sentence I wonder which higher predators are linked to the Antarctic ecosystem? (Geir Wing Gabrielsen, The Norwegian Polar Institute)	Noted, text changed
15-172	A	4	3	4	3	change to "Continuing warming and less sea ice cover in the northern polar oceas …" (Josefino Comiso, NASA Goddard Space Flight Center)	We do not have information confirming the impact of changing sea ice cover on phyto- and zooplankton
15-173	A	4	3			the northern polar ocean and seas are (Robert Jefferies, University of Toronto)	See previous response
15-174	A	4	3	4	6	Several minor edits would help--change "Continuing" to "Continued", delete "on the" and say "the biomass". Then on line 5, say "higher predators, including fish, will be" and the say "detrimental to to all fish stocks"--or something similar. (Michael MacCracken, Climate Institute)	Noted, changes made
15-175	A	4	3			remove 'on' ; further impact the community (Ted Scambos, University of Colorado)	Noted
15-176	A	4	4	4	5	etc….phytoplakton and zooplanton. Evidence also exists for emergence of southern species where tradiational Arctic Specties used to exist (e.g., Arctic Cod being replaced by Caplin in Hudson Bay). The impact of these changes…..etc (David Barber, University of Manitoba)	Already covered to the extent it should be here in the executive summary
15-177	A	4	4			Also impact ice algae. Not clear how warming or increased light will affect phytoplankton. May be nutrient limited. (Larry Hinzman, University of Alaska Fairbanks)	The statements in the chapter are supported by publications, where particular details are discussed
15-178	A	4	4	22	24	This last sentence seems to suggest that it is the stresses other than climate change that are challenging adaptive capacity. But isn't climate change, in combination with these other stresses, presenting the challenges? (Marybeth Long Martello, Harvard University)	Yes, it is, but we do not consider it a key finding
15-179	A	4	4	26	27	States "Recent models that predict displacement of …..emphasize the importance of albedo." How is this a key finding? (Marybeth Long Martello, Harvard University)	Noted, text changed
15-180	A	4	7	4	11	This would be a good spot to mention that changes in the nature of precipitation can also have a severe impact on terrestrial wildlife, eg winter freezing rain episodes	DGV- This section is devoted to the summary of the knowledge expressed in the TAR, and

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						are very hard on the winter foragers. (David E Atkinson, University of Alaska Fairbanks)	so new statements cannot be included. TVC; we already cover extreme winter events such as thawing and freezing. Will check to see if it is possible to add freezing rain reference at this place.
15-181	A	4	7	4	7	Contaminant. specific contminants should be cited here or elsewhere. (Jerry Brown, International Permafrsot Association)	Noted, there is no need to list specific contaminants in the executive summary
15-182	A	4	7			Executive summary ….. will increase contaminat capture. There will also be an increase in contaminant input to the polar areas (see AMAP Pathway report). (Geir Wing Gabrielsen, The Norwegian Polar Institute)	…which will ultimately increase contaminant capture, as stated in the text.
15-183	A	4	7	4	11	Change "This, combined" to "Combined" and then say "permafrost, these changes will increase" and later on line 9 change "may" are likely" (Michael MacCracken, Climate Institute)	Noted
15-184	A	4	7			Executive summary: Not all changes in precipitation will increase contaminant capture. Explain what changes these are in the frequency, type and timing of precipitation. May be better to write: “Increasing precipitation will increase contaminant capture”. (Vladimir Pavlov, Norwegian Polar Institute)	We refer to general changes, which include, but are not limited to increase in precipitation.
15-185	A	4	12	4	12	change to "…the poleward migration of species and competition between polar species and extrapolar species …" (Josefino Comiso, NASA Goddard Space Flight Center)	TVC: will consider wording
15-186	A	4	12	4	13	Change "competition" to "increasing competition" as it will be new and is not existing< and then change "occurring, and" to "occurring. Intensifying changes" (Michael MacCracken, Climate Institute)	TVC- will consider wording
15-187	A	4	15			because many migratory species depend... (Robert Jefferies, University of Toronto)	TVC – will consider wording
15-188	A	4	17			socioeconomic changes should also include migration from the Arctic, as (I understand) has been taking place in northern Russia since the end of the Soviet era, associated with reduced governmental support for populations that themselves had been imported into the region, often associated with military activity, during the Cold War. (Peter Convey, British Antarctic Survey)	Noted, migration issue included in the existing bullet.
15-189	A	4	17			"human communities are already being required to adapt to climate change" (Larry Hinzman, University of Alaska Fairbanks)	What is the question?
15-190	A	4	17	4	17	Change "arctic human communities" to "communities in the Arctic". Then end the first sentence with "climate change" and start a new one saying "The resilience …"	rejected

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Michael MacCracken, Climate Institute)	
15-191	A	4	17		24	missing reference to Traditional Knowledge. As the climate and land change it puts stress on the ability read the land and to pass on oral traditions. It is creating a disconnect that is yet another stress to the culture of indigenous people. (John Streicker, Yukon College)	Rejected for executive summary, the point expressed in many other places throughout the chapter
15-192	A	4	19	4	19	change to "Indigenuous communities need to effectively adapt to climate…" (Josefino Comiso, NASA Goddard Space Flight Center)	rejected
15-193	A	4	19			"Indigenous communities already need to adapt to climate changes" seems a bit redundent? (Larry Hinzman, University of Alaska Fairbanks)	Text reworded
15-194	A	4	19	4	24	This section is poorly written. There are too many points being made which leads to poor sentence construction. I suggest that the section is expanded as necessary. (Robert Jefferies, University of Toronto)	This is in conflict with the reviewer's opinion. Number of bullets is reasonable (compared to 62 in chapter 10, for example)
15-195	A	4	19	4	22	Change this to read "Indigenous communities are already having to adapt to changes in climate and their local environment. Approaches include practices such as adjusting wildlife management regimes and changing hunting practices in ways that allow them to retain at least some capacity to adapt to further environmental change and year to year fluctuations." Or something similar. (Michael MacCracken, Climate Institute)	Noted
15-196	A	4	19			I question the assertion that indigenous communities "retain the capacity to adapt to environmental change". With reference to changes like those of the past, this is a reasonable statement. But how can this be stated with confidence for the future? A warmer Arctic is uncharted territory for many indigenous people. What about the communities that are currently at risk from coastal erosion and ground thawing? What about dependence on country food that is changing its distribution? (James McCarthy, Harvard University)	All statements in the executive summary are based upon the chapter text, which may be referred to for details.
15-197	A	4	19			indigenous peoples have been adapting for thousands of years (John Streicker, Yukon College)	noted
15-198	A	4	21			Clarify what is meant by "retain capacity" (Gordon McBean, University of Western Ontario)	This is just what it means in English
15-199	A	4	22	4	24	Sentence starting with "However, stresses in addition …" is too simplistic. Migration is in and of itself an adaptive response. Second, increased involvement with "employment economies" could, in fact, make people less dependent on climate-sensitive natural resources and help provide them with alternate means of purchasing power. In other words, that should enhance adaptive capacity. See Goklany (1995, 1999). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Rejected. The statements are based upon the existing chapter text.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-200	A	4	22	4	24	I found it confusing to say "from the land" and might suggest "from living individually in the wilderness". Later in that sentence, I would change "challenge this" to "will limit" (Michael MacCracken, Climate Institute)	Noted
15-201	A	4	25			Shifts in vegetation' poor grammar. Vegetation communities, vegetation zones ?? (Peter Johnson, University of Ottawa)	TVC– will consider wording
15-202	A	4	25			Move this bullet to just before 3-33 to keep vegetation issues together and avoid splitting human impacts. (Ian Joughin, Applied physics Lab, University of Washington)	TVC: will check – seems OK
15-203	A	4	26	4	28	I would suggest changing this to read "Vegetation models project displacement of significant areas of tundra by forest, while biogeochemical models project that the tundra will remain a small sink …" (Michael MacCracken, Climate Institute)	TVC– will consider wording but the implied contrast in the suggesting wording is not true.
15-204	A	4	28			"models estimate that the tundra will be a small sink for carbon" Is this one model? For annual cycle? I would be skeptical of these results… (Larry Hinzman, University of Alaska Fairbanks)	TVC TRC. I agree with the gut feeling by Larry but it is nevertheless what the models (and not only one) are saying. Note Dave McGuire mentioned we could refer to both his own papers and Sitch on this point.
15-205	A	4	29	4	31	How about the release of greenhouse gases from the permafrost? This could be a big climate impact! (Josefino Comiso, NASA Goddard Space Flight Center)	In the Executive Summary reference is made to the impact of warming on the exchange of greenhouse gases, and particularly on the increased methane emission from tundra, which is more specific than the generl statement about permafrost.
15-206	A	4	29			should there be some reference at this point to the possibility of carbon release as permafrost thaws? (Peter Convey, British Antarctic Survey)	Not here. This point addresses impact on humans rather than on climate system.
15-207	A	4	29			Comment on bullet. This bullet should be reconciled with the material on p. 42, lines 36-40. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	noted
15-208	A	4	29	4	31	As a general statement this is correct. However, the impact of climate warming is relative small compared to other manmade impacts. This is clearly pointed out in the referred publication from the ACIA report (Instanes et al. 2005). (Arne Instanes, OPTICONSULT Consulting Engineers)	The bullet was rewritten. The new wording does not conflict with reviewer's comment.
15-209	A	4	29			Warming and thawing of permafrost at many locations will have.. (This is going to depend on the nature of the substratum to a large extent) (Robert Jefferies, University of Toronto)	The bullet was rewritten. The new wording does not conflict with reviewer's comment.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-210	A	4	29	4	31	It is important to indicate that it is the warming and thawing of ice-rich permafrost that will have implications for infrastructure. Some structures may require substantial investment for adaptation not all of them. Is this more of a short-term cost, ie. remedial action required for some structures but problem will become less as new structures are buillt which take climate change into account (Sharon Smith, Geological Survey of Canada)	The bullet was rewritten. The new wording does not conflict with reviewer's comment. Details suggested by the reviewer are inappropriate in the executive summary
15-211	A	4	30	4	31	On line 30, change "may" to "are likely to" and change line 31 to read "changes or to relocate them to safer regions." (Michael MacCracken, Climate Institute)	The bullet was rewritten. The new wording does not conflict with reviewer's comment.
15-212	A	4	31	4	31	change word regions to site; not likey to move to different regions. (Jerry Brown, International Permafrsot Association)	Noted, text changed
15-213	A	4	31			The phrase "… or relocate them to regions with safe conditions" is not clear (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted, text changed
15-214	A	4	32	4	33	I think it is important to add one additional point here. Marine mammals rely on stability in the sea ice dynamic the thermodynamic processes. Changes to a more annual form of sea ice will affect roughness of the ice surface thereby affecting habitats for key species such as ringed seal, polar bear and arctic cod. Earlier melting and later freeze-up is know to affect polar bears in Churchill who must fast through the summer months and it likely also affects ringed seals and polar cod predation (in opposing directions). (David Barber, University of Manitoba)	Text changed.
15-215	A	4	32			There ought be bullet noting that the Arctic climate would be less harsh and, as a result, mortality and morbidity due to extreme cold, which currently claims more lives than extreme heat, should drop. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	This is discussed further in the text.
15-216	A	4	32			A major finding with potential huge impacts on the problem is the 'feedback' of releases of methane and carbon from warming Arctic permafrost areas. This has a huge potential to exacerbate the problem far beyond what can be addresses by conservation and sequestration. (Ted Scambos, University of Colorado)	Potential increase of methane emission is noted in the ES
15-217	A	4	34			Summary of TAR; this section could be condensed further as the need of this report is to focus on what is new rather than what people can readily read elsewhere (Fiona Cawkwell, University of Alberta)	Text was changed and condensed
15-218	A	4	34	6	50	Despite the fact that this section reviews the TAR findings, already at this point the ACIA Report may be introduced, as this represents an even more comprehensive assessment of climate change in the Arctic compared to the polar chapter in the TAR.	The basis for the present report is the TAR, and so it is most helpful if the TAR is reviewed exclusively in this section.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Manfred Lange, University of Muenster)	
15-219	A	4	34	4	34	I would suggest changing "Assessed" to "Presented" in the heading (Michael MacCracken, Climate Institute)	Noted
15-220	A	4	34	6	50	The organization of this section could be improved . It would be much more useful if key findings were clustered to indicate which findings from the Third Assessment remain robust and which require revision given new information on specific impacts for Arctic sub-regions. Alternatively, a new section could be inserted following this one that provides in narrative form an overview of areas where there are new findings. The reader needs to know why to keep reading at this point. (James McCarthy, Harvard University)	# Agreed there is some importance in making this clear. Sadly, there is no space for new sections to be added.
15-221	A	4	34			I suggest making the sub-headings into sub-sections (ie 15.1.2 becomes "Climatic changes etc). This will help remind readers that these refer to TAR findings. (Robert Thomas, EG&G Services)	rejected
15-222	A	4	38	4	40	Minor edits--delete "the future" as redundant; Delete "Some of" as I would hope all the KEY findings are indeed presented. And change "are the following: to "include the following" as some other findings might well exist. (Michael MacCracken, Climate Institute)	Accepted
15-223	A	4	42			...have led to... (Robert Jefferies, University of Toronto)	Noted
15-224	A	4	42	4	42	Change "lead" to "led" (Michael MacCracken, Climate Institute)	Accepted
15-225	A	4	42			led not lead (Peter Wadhams, University of Cambridge)	Accepted
15-226	A	4	44			up to 5C in mean annual temperature? (Robert Jefferies, University of Toronto)	Yes
15-227	A	4	44	5	4	Needs comment on regional variability (Peter Johnson, University of Ottawa)	This is a summary of TAR, details are given in the original volume.
15-228	A	4	44	4	44	Change to read "warming of as much as 5 C occurred over extensive land areas" (Michael MacCracken, Climate Institute)	Noted
15-229	A	4	44			"...a warming trend in air temperature of up to 5°C". Where and for what period was such trend observed? (Vladimir Romanovsky, University of Alaska Fairbanks)	In the selected locations in the Arctic, and, as follows from the header, in the 20th century.
15-230	A	4	44	4	50	Are all the changes annual means? Should be specified. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	No, sometimes these are winter temperatures. Details are given in TAR.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-231	A	4	45	4	46	It needs to be said where precipitation increased. (Michael MacCracken, Climate Institute)	Over the whole Arctic.
15-232	A	4	45	4	45	Slight warming -- how much? Is it significant? (Sharon Smith, Geological Survey of Canada)	Not much, not significant, which is why we say “slight”. This is what TAR gives us.
15-233	A	4	46	4	48	It would be better to provide comparable period losses of sea ice and in comparable units. The Arctic numbers are for 1978-96 - there are analyses that bring results up to more recent years. (Gordon McBean, University of Western Ontario)	This is the summary of knowledge from TAR, and we should not go beyond the TAR data.
15-234	A	4	49	4	49	I suggest adding a statement with regards to Atlantic water intrusions. The Atlantic layer also appears to be progressing further into the Arctic Basin and is now available to mix with the halocline thereby enhancing melt (Dmitrenko et al. 2004). (David Barber, University of Manitoba)	This section is devoted to the summary of the knowledge expressed in the TAR, and so new statements cannot be included.
15-235	A	4	49			..the surface layer has become thinner. Significance? (Robert Jefferies, University of Toronto)	Not defined in TAR.
15-236	A	4	49			Comment in "warmed" I interpret this statement to say that the inflowing Atlantic water is warmer; has the Atlantic water in the Arctic also warmed? (Gordon McBean, University of Western Ontario)	See TAR for details
15-237	A	4	50	4	50	insert qualifier: "sporadic and discontinuous " in front of permafrost. This "reduced in extent " is an intuitive statement that lacks verifyable documentation. (Jerry Brown, International Permafrsot Association)	Details are given in TAR, our statement ‘regions underlain by permafrost have been reduced” is absolutely correct and supported by TAR. No more details need to be discussed here.
15-238	A	4	50			..has become less saline. By how much? (Robert Jefferies, University of Toronto)	See TAR for details.
15-239	A	4	50	5	1	Regarding reduction in permafrost extent and warming of ground temperatures - Was this a key finding in TAR? An indication of the time period being considered is required here as well. (Sharon Smith, Geological Survey of Canada)	Details are given in TAR
15-240	A	5	2			How much is the significant decrease in snow cover extent over Eurasia? (Robert Jefferies, University of Toronto)	See TAR for details.
15-241	A	5	5	5	10	The Antarctic temperature history is even more regional than the Northern hemisphere’s. There are studies of centuries-long paleo temperature data sets in both polar regions that demonstrate this . I note that no mention is made of paleo records when they could be of use , like here. (David Fisher, Geological Survey of Canada)	We believe that this is largely the remit of WGI and we only mention palaeo-climate records where they have particularly reference to impacts and adaptation in the polar regions.
15-242	A	5	5	5	6	Again, quantitative information is required. (Robert Jefferies, University of Toronto)	Again, see TAR for details

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-243	A	5	5	5	10	Is there any evidence of thinning of the ice, a major element of change in the Arctic (Peter Johnson, University of Ottawa)	There is no robust data on it in TAR.
15-244	A	5	5	5	5	Delete "trend" as what has occurred is significant warming. (Michael MacCracken, Climate Institute)	Accepted
15-245	A	5	6	5	6	I think stating there is a warming trend elsewhere on the continent is misleading, even considering the text in this chapter. This should just be stated as "Elsewhere, trends are ambiguous" (Peter Doran, University of Illinois at Chicago)	Substantive points, will be checked with WGI and improved to reflect controversy
15-246	A	5	6	5	6	Change "is" to "has been" (Michael MacCracken, Climate Institute)	Accepted
15-247	A	5	7	5	7	Change to read "It is possible that precipitation in the Antarctic has increased" or otherwise get rid of the word "may" (Michael MacCracken, Climate Institute)	This is TAR formulation
15-248	A	5	8	5	8	Change "period. Antarctic" to "period; however, Antarctic" (Michael MacCracken, Climate Institute)	Accepted
15-249	A	5	10			Give the decrease in salinity (Robert Jefferies, University of Toronto)	This is TAR wording
15-250	A	5	11			In the Figure 15.1 is said "Note the ice-covered terrain is shown using a different shading scheme to the one given in the legend.". It is important to describe the shading scheme for the ice-covered area. What does it mean for the general reader? (Jefferson Cardia Simões, Instituto de Geociências)	Figure captions will be changed
15-251	A	5	11			Figure 15.1: the maps are clear, but the one of the Arctic in particular is very busy - maybe rivers and point locations could be listed in a table beside the map and indicated on the figure by a letter/number, also given that the ice covered terrain is shown by a shading scheme that does not have a scale perhaps it would be best if it was just solid white (Fiona Cawkwell, University of Alberta)	Due to strict page limits we may not do it.
15-252	A	5	11			How are the Arctic and Antarctic defined in this chapter? On page 5, the chapter provides two maps showing the polar regions, but does not, as far as I could tell, provide a description of what is meant by the Arctic and Antarctic. Such a description/definition should be added. (Marybeth Long Martello, Harvard University)	There was a definition of these terms in the TAR and we could simply make reference to this, but that was a rather narrow definition. TVC and TP, to provide a couple of sentences on definition.
15-253	A	5	39			Add J. Magnuson et al., 2000. Magnuson, J.D. and 18 others 2000 Historical trends in lake and river ice cover in the Northern Hemisphere. Science, 289(5485): 1743-4 (Roger Barry, University of Colorado)	Comment misplaced

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-254	A	5	46	5	48	The maps, especially the North Polar region is incomplete - it does not, as the legend states, include place names used in the text. Only two of the Arctic regional seas are named. (James McCarthy, Harvard University)	These figures will be revised in line with text revisions.#
15-255	A	6	0			Project climate change in the polar regions have generated eight key regional concerns; What about access to new land areas (pristine areas) when sea ice is melting (i.e. eastern part of Svalbard and Frans Josef land/Severja Zemlja)? This will make these areas more accessible for boats and tourists with implications for the terrain and animals living in these areas. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	These key concerns are listed in TAR.
15-256	A	6	3	6	8	Aside from thermal expansion ALL sea level changes will come from the Cryosphere. Saying the cryosphere will make “a significant contribution” suggests there is another source of water somewhere that will also contribute. It is specifically the East Antarctic ice sheet that will gain thickness by increased accumulation (David Fisher, Geological Survey of Canada)	We don’t see the problem here. There are other sources of sea level rise, thermal expansion, ground-water extraction, lakes/reservoirs etc.
15-257	A	6	4	6	7	This bullet point is not clear, and the second sentence is not properly constructed. Is part of the point that there is a small risk that parts of West Antarctica, and possibly some Greenland outlets, could retreat rapidly/catastrophically over the coming centuries. (Julian Dowdeswell, University of Cambridge)	Noted
15-258	A	6	4	6	4	see comment below (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted
15-259	A	6	4	6	38	One regional concern that is important in Canada and elsewhere is the erosion of low lying coastlines. This could be added to lines 19 to 25 (Robert Jefferies, University of Toronto)	Here we summarize the knowledge and concerns of TAR.
15-260	A	6	4	6	50	Some things are “likely will happen” others are “will happen”. Its not clear if this is inconsistent wording or whether “likely” vs. “will” suggests differences in degrees of confidence. (Ian Joughin, Applied physics Lab, University of Washington)	Reflect different confidence.
15-261	A	6	4	6	5	It would read better to say "Increased melting of arctic glaciers and the Greenland Ice Sheet is expected, while, on average, the Antarctic … (Michael MacCracken, Climate Institute)	Accepted
15-262	A	6	4	6	7	Unless it's stated that the supposedly likely thickening of the Antarctic ice sheet will be more than counterbalanced by the ice decreases elsewhere, the concluding point that "cryosphere changes will make a significant contribution to sea level rise" doesn't follow logically, despite the text's suggestion that it does.	Accepted, but we are not arguing the point here, we’re stating what the TAR said

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Claire Parkinson, NASA Goddard Space Flight Center)	
15-263	A	6	5		7	Is this a complete sentence?? "Together with the small risk that the West Antarctic and Greenland ice sheets retreat in coming centuries, suggest that the cryosphere changes will make a significant contribution to sea level rise." Why do you think it is a small risk that the Greenland ice sheet will retreat? (Larry Hinzman, University of Alaska Fairbanks)	Accepted, but we are not arguing the point here, we're stating what the TAR said
15-264	A	6	5	6	7	Sentence grammatically incorrect (Peter Johnson, University of Ottawa)	accepted
15-265	A	6	5	6	7	I am quite baffled by this sentence. On what basis is there a "small risk" that these ice sheets will retreat I coming centuries? About half of both the Greenland and West Antarctic Ice sheets apparently melted during the Eemian (see paleoclimate chapter of WG I), and the Eemian was about the warmth we should experience by 2100. Of even more concern, much of the melting apparently occurred over a few centuries. Given the last phrase of the sentence, it may well be that this is what is meant, but then "small risk" is the wrong term--and should be changed to "likelihood" or even "strong likelihood" (Michael MacCracken, Climate Institute)	Accepted, but we are not arguing the point here, we're stating what the TAR said
15-266	A	6	5	6	6	The statement is that of a small risk. Is that appropriate in view of the Hansen and Exeter results? (Gordon McBean, University of Western Ontario)	Accepted, but we are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-267	A	6	5	6	7	Looks like some part of this sentence is missing (Vladimir Romanovsky, University of Alaska Fairbanks)	Accepted
15-268	A	6	5	6	7	This sentence does not make sense (Robert Thomas, EG&G Services)	Accepted
15-269	A	6	6		7	indicate also value for estimated sea level change due to the glacier melting (mm/years) (Jari Haapala, Finnish Institute of Marine Research)	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-270	A	6	6	5	7	The sentence beginning with "Together…" is awkward, needs to be rewritten. (Marybeth Long Martello, Harvard University)	Accepted
15-271	A	6	6			Evidence seems to suggest that the retreat of the Greenland ice sheet is more than a "small risk" (Gunter Weller, University of Alaska)	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-272	A	6	7	6	7	really "glacier and ice cap melt" not cryosphere (Jerry Brown, International Permafrsot Association)	Accepted
15-273	A	6	8	6	9	Is this likely to occur only in the Antarctic Peninsula - surely it is also an issue in Greenland, Arctic Canada, Siberia… (Fiona Cawkwell, University of Alberta)	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-274	A	6	9	6	9	It would help to add "in this region" to the end of the sentence. (Michael MacCracken, Climate Institute)	Surely, this can be taken as read?
15-275	A	6	10			which has resulted in an increased availability (Roger Barry, University of Colorado)	Comment misplace in relation to text
15-276	A	6	10		11	This is a very strange statement and need to be removed. Physical oceanography will not change, there might be changes in the physical characteristics of the physical environment in the Southern Ocean, but physics remains same. Moreover, if there changes in the physical environment, like stratification changes, those changes are very likely reversible. (Jari Haapala, Finnish Institute of Marine Research)	Accepted, but this is the phrase used in the TAR!
15-277	A	6	10	6	11	This sentence is unclear--"physical oceanography" is a discipline--what needs to be said are what will be varying, and even if this were changed to "physical characteristics" it would not be useful. (Michael MacCracken, Climate Institute)	Accepted, but this is the phrase used in the TAR!
15-278	A	6	11			….oceanography and ecology of the Southern AND ARCTIC oceans (Gunter Weller, University of Alaska)	Not a finding of the TAR
15-279	A	6	12	6	12	There will be a sustantial loss of multiyear sea ice which in turn will be replaced by first-year sea ice. This will dramatically effect many sea ice related physical and biological processes. Comment - I also believe that current estimates are for an ice free arctic by about 2050 (if you use the passive microwave data and several models; 2070 if you use some of the IPCC models. Thus the comment of 60% summer minimum should be revisited. (David Barber, University of Manitoba)	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-280	A	6	12	6	13	Change "summer ice" to "summer sea ice" and clarification is needed about the meaning of "for a doubling of CO2"--is this at the time of CO2 doubling, for stabilization at two times CO2, what? (Michael MacCracken, Climate Institute)	Accepted Reader and reviewer are referred to the TAR
15-281	A	6	14	6	18	As a general statement this is correct. However, regarding infratructure, the statement is speculative. I also have a problem understanding the large reduction in areas underlain by permafrost. Is the analyses based on steady-state thermal analyses? (Arne Instanes, OPTICONSULT Consulting Engineers)	Reader and reviewer are referred to the TAR
15-282	A	6	14	6	18	On line 15, change "about" to "above"; on line 16, what does "mass movements" mean, and what does "thermal erosion" mean. On line 17, change "human" to "built" (Michael MacCracken, Climate Institute)	Accepted I think we can loose some of this anyway. Disagree

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
15-283	A	6	14	6	15	The sentence is not clear. Also, what is the time scale of these expected changes? (Vladimir Romanovsky, University of Alaska Fairbanks)	This is a general summary of findings from TAR, Details are given in the TAR.
15-284	A	6	14	6	18	Much of the changes mentioned here depend on the thawing of ice-rich ground -- it is important to mention that it is the thawing of ground ice that leads to these impacts. Another impact to mention is thaw settlement (Sharon Smith, Geological Survey of Canada)	This is a general summary of findings from TAR, Details are given in the TAR.
15-285	A	6	15	6	15	above not about (Jerry Brown, International Permafrsot Association)	Changed
15-286	A	6	15			replace "about" with "above" (John Calder, National Oceanic and Atmospheric Administration)	Changed
15-287	A	6	15			thawed layer above permafrost (Robert Jefferies, University of Toronto)	Changed
15-288	A	6	15			about' should be 'above' (Peter Johnson, University of Ottawa)	Changed
15-289	A	6	15			change "about" to "above" (Gordon McBean, University of Western Ontario)	Changed
15-290	A	6	17	6	17	add 'exisiting" in front of human (Jerry Brown, International Permafrsot Association)	Added
15-291	A	6	17		18	human infrastructure? As opposed to…. (Larry Hinzman, University of Alaska Fairbanks)	Changed
15-292	A	6	19	6	21	It is not at all clear that there will be a shift to a hydrologic regime with "less seasonal variation." The winter baseflow increases, while significant in term of % (winter) increase, remain very small in comparison with the full magnitude of the seasonal cycle range in discharge. Even within this chapter there are conflicting predictions regarding the possible future of spring and summer flows. Also, "There will be more ponding of water in some areas of peatland/wetlands dry" makes no sense, either as written or scientifically. Evidence presented elsewhere in the chapter suggests that ponding will increase in continuous permafrost areas as thermokarst develops, and decrease futher south as permafrost degrades still further. (Laurence C. Smith, University of California, Los Angeles (UCLA))	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-293	A	6	19	6	20	As permafrost thaws, there will be increases in infliltration and base flow. (Sharon Smith, Geological Survey of Canada)	We are not arguing the point here, we're stating what the TAR said and no new material will be introduced
15-294	A	6	20	6	21	Sentence does not make sense (Fiona Cawkwell, University of Alberta)	Text changed.
15-295	A	6	20	6	21	"There will be more ponding of water in some areas of peatlands/wetlands dry".	Text changed

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						This is an incomplete sentence. (Bruce Forbes, University of Lapland)	
15-296	A	6	20		21	"There will be more ponding of water in some areas of peatlands/wetlands dry." What does that mean? (Larry Hinzman, University of Alaska Fairbanks)	Text changed
15-297	A	6	20	6	21	Grammar (Peter Johnson, University of Ottawa)	Text changed
15-298	A	6	20	6	21	This sentence is unintelligible. (Peter Lemke, Alfred Wegener Institute)	Text changed
15-299	A	6	21			replace "of" with "if" (John Calder, National Oceanic and Atmospheric Administration)	Text changed
15-300	A	6	21			What does this mean? "dry" (Gordon McBean, University of Western Ontario)	Text changed
15-301	A	6	21	6	23	The meaning of this sentence is not clear. (Gordon McBean, University of Western Ontario)	Text changed
15-302	A	6	21			The phrase "… more ponding of water in some areas of peatlands/wetlands dry" is incomprehensible (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed
15-303	A	6	21			Sentence ending "peatlands/wetlands dry" makes no sense. (Robert Thomas, EG&G Services)	Text changed
15-304	A	6	23	6	25	Is it reasonable to hold this up as a main area of concern for the reason stated? That is, weakening THC is a concern, but is river outflow a sufficient source to trigger this problem, and should be highlighted in so prominent a position in the document? I think the question of where river hydrology will go is too murky to link into THC for the moment - other issues for rivers are many have extensive control structures on them, and the magnitude and nature of the runoff freshet would alter, perhaps "softening" the low-saline "blow" to the THC. (David E Atkinson, University of Alaska Fairbanks)	THC changes are in the focus of WG-1, which is why we only acknowledge them here at the end of the bullet.
15-305	A	6	23	6	25	The whole “thermohaline weakening” topic is an important research area at the moment and alluding to its importance is justified, but any hint that its effects are understood, is premature. Models are useful here but they are still at a primitive stage and are pre-predicative. Paleo-analogue studies are ongoing as are oceanographic campaigns to get a better handle on the sensitivities of “thermohaline /bottom water production” to freshwater inputs from a melting cryosphere. (David Fisher, Geological Survey of Canada)	This is a general summary of findings from TAR, Details are given in the TAR.
15-306	A	6	23	6	25	A major ompact' needs to be much more specific	This is a general summary of findings from

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Peter Johnson, University of Ottawa)	TAR, Details are given in the TAR.
15-307	A	6	24	6	25	Thermohaline circulation also affected by brine rejection from sea ice and glacier/ice sheet runoff. This is stated more clearly on page 6, lines 43-45. (Julian Dowdeswell, University of Cambridge)	This is a general summary of findings from TAR, Details are given in the TAR.
15-308	A	6	25	6	25	Change "from the Arctic Ocean" to "into the Arctic and North Atlantic oceans." (Michael MacCracken, Climate Institute)	Rejected
15-309	A	6	26	6	29	I think this point should be more forceful and carry a distinct air of concern - stating that "biological production will increase" almost sounds like a good thing. Species assemblage shift means potential severe ecosystem impact, with attendent problems for those species dependent on the ecosystems, including humans. Another point in this regard that should be stated more often is the great possibility of increasing animal disease as a) seasonality grows less harsh (a natural disease limiter), and b) invasive species introduce pathogens against which indigenous species have inadequate natural defense. (David E Atkinson, University of Alaska Fairbanks)	TVC: increase in production will be good to some sectors and some biodiversity. I strongly disagree on hiding potential benefits of climate change. We defend the position that Climate Change impacts in some areas, and from some perspectives can (on balance) have positive implications. We believe that this is one possibility. Also, I removed the section on disease because of need to condense: it was there originally.
15-310	A	6	26			vital roles in the (Roger Barry, University of Colorado)	TVC– will consider wording
15-311	A	6	26	6	26	Change "should" to "is likely to" and "will" to "are likely to" in order to better conform to IPCC lexicon. (Michael MacCracken, Climate Institute)	TVC– will consider wording
15-312	A	6	28	6	29	It could be added that this may have political implications, as the distribution of fish stocks between countries´Exclusive Economic Zones may change. This may generate conflicts among countries and require the negotiation of new agreements on management of such fish stocks. (Alf Håkon Hoel, University of Tromsø)	This is a general summary of findings from TAR, Details are given in the TAR.
15-313	A	6	28			..the shifts in species assemblages. This is somewhat ambiguous as it implies that the species move as a group, which I am sure was not the intention of the authors. (Robert Jefferies, University of Toronto)	TVC– will consider wording
15-314	A	6	28			We have stated several times, also in relation to the ACIA report, that we find it	This is a general summary of findings from

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						erroneous to consider the walrus dependent on sea ice, and that the species will suffer from reduced ice cover. On the contrary, we estimate that the species will benefit from increased access to shallow seas, otherwise ice covered for much of the year, and from increased marine productivity. Please see attached paper on walrus and climate. (Hans Meltofte, National Environmental Research Institute)	TAR.
15-315	A	6	30	6	38	This paragraph does not draw attention to regional concerns of navigation in the Arctic, including the need for navigation aids, who controls the seas, insurance, establishment of coastal infrastructure, shipping accidents and who pays. (Robert Jefferies, University of Toronto)	This is a general summary of findings from TAR, Details are given in the TAR.
15-316	A	6	31	6	38	Again, an implication of optimism. Any increase in economic activity means great increases in chances for pollution. This is a problem not simply for the envionrment, but also for the nation closest to the problem (especially if it is a catastrophic single event, such as the Selendang Ayu, i.e. and not a chronic problem) - this means that they have to take on search and rescue and clean up responsibilities. With the Ayu a US Coast Guard helicopter crashed and members of the US National Weather Service, amongst other agencies, put in a lot of extra, expensive, duty to cope with the problem. From the environmental side, it should be pointed out that cold regions recover less rapidly from such occurrences; as well they are more difficult to get to and often to work in. Further, in several northern regions the nature of atmospheric circulation means that poor weather can be very persistent. Again with the example of the Ayu, early winter weather conditions in the Aleutians are not inducive to clean up and rescue operations. (David E Atkinson, University of Alaska Fairbanks)	This is a general summary of findings from TAR, Details are given in the TAR.
15-317	A	6	33	6	33	Change "may" to "are likely to" (Michael MacCracken, Climate Institute)	Accepted
15-318	A	6	33			Communities may lose their cultural identity with loss of polar bears. (Gordon McBean, University of Western Ontario)	This is a general summary of findings from TAR, Details are given in the TAR.
15-319	A	6	34	6	36	Agree, but it should be noted that if the permafrost disappeared, the infrastructure cost would be much lower than today. It is the transition period that is very costly. (Arne Instanes, OPTICONSULT Consulting Engineers)	This is a general summary of findings from TAR, Details are given in the TAR.
15-320	A	6	34			Increased economic costs do not affect the infrastructure - the melting permafrost does, leading to increased costs. (Gordon McBean, University of Western Ontario)	Accepted
15-321	A	6	36	6	38	Loss of ice/snow cover will also impact the ease with which mineral and fossil fuel reserves can be exploited (Fiona Cawkwell, University of Alberta)	This is a general summary of findings from TAR, Details are given in the TAR.

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15-322	A	6	36	6	38	This should be a separate point, so drop "However" and say "There will be some economic benefits …" (Michael MacCracken, Climate Institute)	Accepted
15-323	A	6	36			….across frozen ground, SNOW COVER, and water (e.g. ice and snow roads impacted by climate change) (Gunter Weller, University of Alaska)	Accepted
15-324	A	6	38			what about fisheries? (Larry Hinzman, University of Alaska Fairbanks)	Not clear in TAR
15-325	A	6	38			With the increased industrial and marine use of the Arctic, there is also increased risk of environmental damage due to more pollution and potential for major spills. (Gordon McBean, University of Western Ontario)	Missed in TAR
15-326	A	6	41	6	45	Both of these bullets could be logically followed with statements that say " which causes …" (Gordon McBean, University of Western Ontario)	Noted
15-327	A	6	43	6	45	This point should not be left as is because, as a driver, slowing of the THC has as one if its more pronounced effects a cooling in the European and NW Russian sectors. This is a negative feedback the results of which would be difficult to gauge - I.e. more snow staying longer in these areas does what to larger scale circulation, which has what potential +/- feedback downstream etc. That is, a word of implication should appear here, as for the point occupying lines 41-42 above. (David E Atkinson, University of Alaska Fairbanks)	The statement will be edited
15-328	A	6	43	6	45	What does the potential slow down of the oceanic thermohaline circulation actually mean for climate changes (Fiona Cawkwell, University of Alberta)	This is the a question to WG-1 report
15-329	A	6	43		45	Present understanding is that the changes in the THC are mostly due to the changes in the surface heat fluxes (WG1, Chapter 10, p. 22) (Jari Haapala, Finnish Institute of Marine Research)	This is a general summary of findings from TAR.
15-330	A	6	43	6	45	Although this concern is widely discussed, I think that we need a time scale or a statement about the volume of water through the Fram Straits and elsewhere which is needed to slow the thermohaline circulation. (Robert Jefferies, University of Toronto)	This is a general summary of findings from TAR, Details are given in the TAR.
15-331	A	6	43	6	44	On line 43, change "may" to "is likely to" and on line 44 change it to read "increased runoff from arctic rivers as a result of a greater increase in precipitation than evaporation, … (Michael MacCracken, Climate Institute)	Accepted
15-332	A	6	44	6	45	The phrasing here is ambiguous and should be revised for clarity. (Claire Parkinson, NASA Goddard Space Flight Center)	Text changed

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15-333	A	6	45			Needs a statement about the consequences of this (Gunter Weller, University of Alaska)	This is a general summary of findings from TAR, Details are given in the TAR.
15-334	A	6	46	6	50	On line 46, change "act as both" to "act, depending on circumstances, as" in that both do not occur at the same time; on line 47, can drop "over vast areas"; on line 48 change "uptake" to "uptake of CO2" and on line 49 change "may" to "is likely to" (Michael MacCracken, Climate Institute)	Accepted
15-335	A	6	46	6	50	The impact of climate change on the carbon balance associated with thawing of permafrost-affected peatlands is not straight forward. Is it not rather simplistic to say that climate warming will lead to an increase in the contribution to greenhouse gas. The last sentence of the bullet should be rewritten to reflect that permafrost thaw will lead to changes in water content and peat decomposition. (Sharon Smith, Geological Survey of Canada)	TVC TRC. I'm confused about this comment and what is actually asked for. But I can see some need for rephrasing the sentences that I believe is referred to.
15-336	A	6	48	6	49	It is not clear why the Southern Ocean's uptake of CO2 would decline, as lessened sea ice would allow more direct contact between the liquid water and the atmosphere. (This is within the section summarizing knowledge from the TAR, and so if an explanation is given there, it would be useful to add a few explanatory words here.) (Claire Parkinson, NASA Goddard Space Flight Center)	This is a general summary of findings from TAR, Details are given in the TAR.
15-337	A	6	49	6	50	Rising CO2 emsissions from tundra warming contradicts the statements on page 4 line 28 of models estimating the tundra to be a carbon sink - this needs to be clarified (Fiona Cawkwell, University of Alberta)	TVC TRC . Yes, but at the same time this only reflects the state-of-art in our understanding. I will clarify and update this statement.
15-338	A	6	50	6	50	Thawing of permafrost: I have a problem with this term. It is repeated a lot and the reader gets a feeling that climate warming will thaw and melt away (all?) permafrost. If the air temperature output from a GCM is applied in a transient heat exhange model between the ground and atmosphere it can be shown that this is in general a very slow process (time scale more than 100 years). Thawing of permafrost, in my opinion, has more to do with ongoing natural processes (for example coastal and river erosion) ponded water, drainage patterns and manmade interference (construction work) than with climate change. (Arne Instanes, OPTICONSULT Consulting Engineers)	TVC + others. This is true and not true. There are areas that are indeed seeing already complete disappearance of permafrost as eluted to in the text. But even in permafrost areas where it is a "slow process" of complete permafrost thaw there has been observed increases in active layer depth which has immediate consequences for hydrology and other important drivers of many important ecosystem processes. References will be added to indicate evidence that discontinuous permafrost is thawing OAA to respond (material from Fritz Nelson)

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15-339	A	7	2			lakes ,… have warmed by (Roger Barry, University of Colorado)	JW: Changed “has” to “have” – this was actually on p. 9, line 19 of FOD.
15-340	A	7	3			Much of the chapter is clearly written and easy to follow. However, the flow and length of the chapter could be improved by dissolving Section 15.2 and integrating its contents into subsequent chapter sections. It is unclear that section 15.2 speaks directly to the concepts of sensitivity, vulnerability, and adaptive capacity (see comments below). Dropping some portions of this material and incorporating others into later sections would make for a clearer and tighter organization. Accommodating 15.2 into later sections may require that the word "future" be dropped from the title of Sections 15.3 and/or 15.4. Sub-Sections within 15.4 with titles like 15.4.1.1 "Arctic freshwater systems and historical changes" and 15.4.2.1 "Historical and current changes in arctic terrestrial ecosystems" also suggest that dropping reference to "future" in the 15.4 title would more accurately reflect the current contents of this section. This section is titled "Current sensitivity and vulnerability," but there is no discussion of what these terms mean and how the conditions they refer to are assessed. An introductory discussion of these concepts and how they inform and shape the section should be added. Overall, it is not clear how the material in section 15.2 relates to the concept of sensitivity. Also see above comment for dropping this section. (Marybeth Long Martello, Harvard University)	JW: While we agree that Section 15.2 is awkwardly place, we were ordered by the TSU to organize our chapters into this sequence of headings. If it were not for this constraint, Section 15.2 would not be where it is. Nevertheless, we have deleted three full paragraphs from the earlier version of this section. The definitions of sensitivity and vulnerability should be presented earlier in this volume, prior to the collection of chapters that were required to include such a section.
15-341	A	7	5			Comment on Section 15.2.1. This document is supposed to be about climate change, but here the discussion is deals with the relatively near term. As noted in comment 1, the current situation should be placed in a long term context so that the reader can judge whether (or not) the variations that we see currently are outside the range of natural variability. This would mean looking, wherever possible, at variations over past centuries, if not longer. That would help answer questions regarding whether current changes are within the bounds of natural variability. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	JW: This is a prime example of an issue appropriate for Working Group I, and it belongs to WG I.. It is addressed, to varying degrees, in the first several chapters of the WG I report.
15-342	A	7	7			Comment on "Arctic" subsection. Over what period has has the Arctic experienced "nearly twice the... warming"? This portion should be rewritten with greater precision. Certainly the Arctic has seen a warming since the 1960s, but one cannot discuss CC only in the context of the past few decades. One needs a longer term perspective. Such data as are available indicate that today's temperatures are no warmer than what they were during the 1930s. There was, as is indicated in Polyakov (2003), a rapid warming in the 1920s & 30s, followed by cooling through	JW: The first paragraph (p. 7, lines 8-24) of Section 15.2.1 is quite specific about the time periods of the changes described therein. The paragraph included the reference to Polyakov et al. (2003), together with the statement that “the 20th-century temperature record [for the marine Arctic] is marked by strong low-

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						the 1960s, followed by the current warming. This is consistent with GISTEMP data, maintained by Jim Hansen et al. at: http://data.giss.nasa.gov/gistemp/tabledata/ZonAnn.Ts.txt, for trends for 64 N to 90N. Thus it's not clear that the current warming is out of the range of natural variability. See the following referencess, for instance: [1] Polyakov, I.V., Alekseev, G.V., Bekryaev, R.V., Bhatt, U., Colony, R.L., Johnson, M.A., Karklin, V.P., Makshtas, A.P., Walsh, D. and Yulin A.V. 2002. Observationally based assessment of polar amplification of global warming. Geophysical Research Letters 29: 10.1029/2001GL011111. [2] Polyakov, I.V., Bekryaev, R.V., Alekseev, G.V., Bhatt, U.S., Colony, R.L., Johnson, M.A., Maskshtas, A.P. and Walsh, D. 2003. Variability and trends of air temperature and pressure in the maritime Arctic, 1875-2000. Journal of Climate 16: 2067-2077. [3] Przybylak, R. 2000. Temporal and spatial variation of surface air temperature over the period of instrumental observations in the Arctic. International Journal of Climatology 20: 587-614. [4] Przybylak, R. 2002. Changes in seasonal and annual high-frequency air temperature variability in the Arctic from 1951-1990. International Journal of Climatology 22: 1017-1032. [5] Taurisano, A., Boggild, C.E. and Karlsen, H.G. 2004. A century of climate variability and climate gradients from coast to ice sheet in West Greenland. Geografiska Annaler 86A: 217-224. [6] Chylek, P., Box, J.E. and Lesins, G. 2004. Global warming and the Greenland ice sheet. Climatic Change 63: 201-221. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	frequency (multidecadal) variability". We have added a second reference to ACIA Chapter 2, which contains a thorough assessment of recent Arctic temperature variations in the context of longer-term records..
15-343	A	7	7			15.2.1 (Arctic) There is no information about changes of marine physical environment such as sea water temperature, salinity, water circulation and sea level. There is no information about changes of atmospheric processes in the Arctic: such as decreasing of sea level pressure, cyclonic activities, etc. (Vladimir Pavlov, Norwegian Polar Institute)	JW: Changes in the marine physical environment are appropriate for this chapter insofar as they relate to impacts and vulnerability. Otherwise they belong in the WG I chapter on the oceans. We discuss these changes in the context of impacts in Sections 15.4.3 and 15.4.5.
15-344	A	7	7			In the section on Arctic climate state, there are no references to present storm climate. Storms are the most important factor in controlling rates of coastal change and flooding in the open water season. A recent paper by Atkinson (2005 - Geomarine Letters) describes open water storm climatology and trends along the Arctic margin using coastal observations. (Steven Solomon, Geological Survey of Canada)	JW: Reference and statement about arctic storms have been added in Section 15.2.1 (Arctic).
15-345	A	7	8			Would it be helpful to define "Arctic" at this point? The domain of arctic ecosystems is treated on p. 10	JW: Definition of Arctic (as used in this chapter) has been inserted in Section 15.1.

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						(James McCarthy, Harvard University)	
15-346	A	7	9	7	9	First of many references to the ACIA. In this case, not even to a specific chapter. See general comment above. (Philip Hill, Geological Survey of Canada)	JW: ACIA Chapter number has been inserted.
15-347	A	7	9	7	9	Change to "has been 1-2 C" (Michael MacCracken, Climate Institute)	JW: Changed as suggested. (See response to following comment).
15-348	A	7	9	7	9	Change "ACIA, 2004" to "ACIA, 2005" as that really has the best information--and being published in Nov 2005. Should probably cite the actual chapter in that book (I think it is chapter 2). (Michael MacCracken, Climate Institute)	JW: Changed as suggested; Chapter number has been added, and the specific chapter is now cited.
15-349	A	7	9			As the lead author of Chapter 2 of ACIA, and the one that this information derives from, it is the only time that the whole ACIA reference is used, rather than the chapter and the authors - McBean et al. (Gordon McBean, University of Western Ontario)	JW: See response to preceding comment.
15-350	A	7	11	9	11	The phrasing "strong, low-frequency (multidecadal variations" makes it sound as if this clearly natural, when this may not be the case, as the multi-decadal variations in NH surface temperature had a strong anthropogenic component--and so the much smaller arctic region likely had a similar mixed set of influences. (Michael MacCracken, Climate Institute)	JW: Newly added sentence notes that attribution involves both natural variability and anthropogenic forcing.
15-351	A	7	11	7	12	The wording implies that the most recent warming is natural variability, not due to GHG-induced warming. Chapter 2 of ACIA did discuss this issue carefully and commented on the attribution question. They also commented on the relative warming in the last few decades relative to earlier in the century. This information is important and should be mentioned. (Gordon McBean, University of Western Ontario)	JW: Newly added sentence, which includes a reference to Chapter 2 of ACIA, notes that attribution involves both natural variability and anthropogenic forcing.
15-352	A	7	12	7	15	Would be helpful to have values here to say what is menat by stong/small warming (Fiona Cawkwell, University of Alberta)	JW: The sentence as written states that the seasons of the strongest warming during the post-a980 period are winter and spring, while the season of smallest warming is autumn. Because the warming varies spatially, the statement would be unnecessarily complicated if numerical values for different regions had to be included. Similarly, the spatial dependence varies seasonally but is generally strongest over northern Asia and northwestern North America as stated. We believe that the present statement conveys the maximum information

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							with minimal verbal baggage.
15-353	A	7	12	7	13	This statement is controversial and a reference should be provided. Other studies show that warming is strongest in spring and autumn and not so strong in winter (Comiso, 2003; Overland and Wang, 2005). (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Our statement is supported by McBean (2005, reference inserted) and also by the temperature maps of J. Hansen (http://data.giss.nasa.gov/gistemp/maps/). The Comiso results are based skin temperatures from AVHRR, and those are limited to clear-sky conditions.
15-354	A	7	12	7	16	Please give a reference. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	JW: Reference to McBean (2005) has been added.
15-355	A	7	13	7	13	This should not be so broad brushed for all of N. Asia. ACIA (ch 2, full science report) indicates that recent warming is not uniformly expressed over the entire region or by season. The previous sentences in this document do inticate seasonal differences, but I think it is important to indicate that warming trends can exhibit real spatial patchiness. (David E Atkinson, University of Alaska Fairbanks)	JW: Have inserted the phrase “interior portions of” prior to “northern Asia and northwestern North America”.
15-356	A	7	15			.the past several decades. (Add reference). (Robert Jefferies, University of Toronto)	JW: Reference to Turner et al. (2006) has been added.
15-357	A	7	16	7	18	By how much have temperatures cooled (Fiona Cawkwell, University of Alberta)	JW: Details on physical changes such as stratospheric cooling are more appropriate to WG I, especially since our chapter does not deal with impacts of the stratospheric cooling. We have added a reference to WG I.
15-358	A	7	16	7	18	Clearly another reason for the stratospheric cooling was the CO2 increase, and this should also be mentioned. (Michael MacCracken, Climate Institute)	JW: Have inserted “increases in greenhouse gas concentrations” as an additional factor.
15-359	A	7	16	7	16	Change "time period" to "time period, likely as a result of their tight connection to cold, deep waters." (Michael MacCracken, Climate Institute)	JW: Suggested change has been made.
15-360	A	7	19	7	21	This statment is hanging loose and the information it is providing is very vague. A reference is absolutely necessary if this is to be kept and in addition rewriting. (Elisabeth Isaksson, Norwegian Polar Institute)	JW: Have added reference to McBean (2005). The stated rate of precipitation increase, about 1% per decade, does not seem vague – it may even be overly precise, given the limitations of precipitation data.
15-361	A	7	22	7	22	Regarding the phrase "irregular increase"--this seems to imply that what one would expect to see from human influences is a regular increase, when this is clearly a too	JW: We have added “generally consistent with changes temperature and the large-scale

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						simplified presumption. Given that human influences caused an irregular increase in NH temperature during the 20th century (in fact, an increase, then decrease, then increase), should we be expecting anything other than this for precipitation--in that the temperature changes likely caused readjustments of various circulation patterns, and with river basins being irregular shapes, again, it would not be surprising at all if the human influence were not a regular increase. (Michael MacCracken, Climate Institute)	atmospheric circulation" to the statement in question.
15-362	A	7	23	7	24	This sentence needs to follow on from the earlier sentence on precipitation (lines 19-21) (Fiona Cawkwell, University of Alberta)	JW: Sentence has been relocated as suggested.
15-363	A	7	23	7	24	I believe K. Steffen has data on accumulation from up to 19 AWS over Greenland. Moreover, it has show remarkable spikes in accumulation associated with low sea ice in Baffin Bay. Other data from radar altimetry and laser altimetry (Thomas; Zwally) indicate some increases in accumula- tion generally over higher parts of Greenland. (Ted Scambos, University of Colorado)	JW: In the absence of a citable reference to Steffen, and in view of the discussion in WG I's Chapter 4 covering the recent variations of Greenland's mass balance, we believe that this is best left to WG I. We need to use our space for discussion of impacts, not the physical changes themselves.
15-364	A	7	24			There should also be some reference to cloud cover - the fact that little is currently known about the current frequency and type of cloud cover across the Arctic, that it represents one of, if not the greatest uncertainty remaining in climate modelling, but that it plays a large role in controlling the radiative balance at the surface and thus melt of snow and ice as well as being closely tied to precipitation (Fiona Cawkwell, University of Alberta)	JW We agree that this issue is important in climate modelling, but its discussion is more appropriate for WG I, especially WG I's chapter on climate models.
15-365	A	7	24			The role of macro oscillatory systems such as NAO should also be mentioned, the prevailing recent mode and the effect changes in mode have on climate (Fiona Cawkwell, University of Alberta)	JW: We have added a mention of the North Atlantic Oscillation at the end of ther paragraph in question.
15-366	A	7	26	7	27	I would think that the ordering of this sentence (at least for sea ice) is reversed--that is, this should read: In the Arctic and sub-Arctic, changes in sea ice cover have led to significant changes in temperature." One can certainly have changes in ice amount without changes in temperature (happens in a glass of ice water all the time), so the logic of the original sentence is a bit suspect. And glaciers can change amount with or without change in temperature--just get more IR coming down on them, or the meltwater running off so that all the incoming energy is used for melting and none for evaporation. (Michael MacCracken, Climate Institute)	JW: This entire paragraph has been deleted because it is more appropriate for WH I. In our chapter, we must focus on impacts, not physical processes.
15-367	A	7	27	7	29	Can reference be made to the continuation of this trend with September 2005 recording the lowest summer ice minima - I'm not sure there will be any refereed	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered

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						literature on this subject but plenty of grey literature coming out of NSIDC at the end of September from Mark Serreze (Fiona Cawkwell, University of Alberta)	by) WG I.
15-368	A	7	27	7	28	Consistency issue. quoting different %ages over diffeerent time periods cf 4-46 4-47 (Peter Johnson, University of Ottawa)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-369	A	7	28	7	29	The 1973-2002 period mentioned here did not have "near-continuous satellite passive microwave measurements." That phrase would be more appropriate for the period since late 1978; however, even with that revision it's not accurate, as the measurements are from polar-orbiting satellites and have never been continuous, even for a single day. Hence "near-continuous" should be deleted. Suggested revision: Replace "the period of near-continuous satellite passive microwave measurements" by: "as found from satellite passive microwave and ancillary measurements." (Claire Parkinson, NASA Goddard Space Flight Center)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-370	A	7	29	7	30	replace the sentence that starts with "The summer minimum…" with the following: "The Arctic perennial ice cover (primarily thick multiyear ice that survives the summer melt) has been reported to be rapidly declining (Comiso, 2002) and recent updates indicate that the rate of decline has increased to 9.8% per decade (Comiso, in press). (Josefino Comiso, NASA Goddard Space Flight Center)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-371	A	7	30	7	30	etc…rate tant he winter maxima. The minimum sea ice concentration on record was recorded for the end of September, 2005 (Serreze, pers comm.) (David Barber, University of Manitoba)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-372	A	7	30	7	30	For clarity, I would suggest changing this to read "Estimates of the decrease in sea ice thickness over the past few decades range from …" (Michael MacCracken, Climate Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-373	A	7	30	7	31	It's important when giving the 10% and 32% estimates of sea ice thickness decreases to indicate the respective time frames. (Claire Parkinson, NASA Goddard Space Flight Center)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-374	A	7	30	7	31	I disagree strongly with this section. Firstly, why is Holloway and Sou quoted (line 31) as an authority on estimation of sea ice thickness decrease when this was purely a modelling study (and one which stands apart from the mainstream of sea ice models)? Surely such estimates should be based purely on data. In this respect the Yu et al reference is appropriate as it is an update of the work of Rothrock et al (1999) , though that earlier reference is also fit to be quoted and gives a higher value of 40% for summer retreat. Also Wadhams and Davis (2000) is still relatively	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.

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						"recent" and quote 43% for summer retreat. BUT MOST IMPORTANTLY, THE PERIOD OVER WHICH THE DECREASE IS ESTIMATED IS NOT GIVEN. The reader might imagine it happened in a single year! You have to add something like "from the mid 1970s to the late 1990s". And the only apprpriate sources, since they are based on real thickness data from those periods, are Rothrock et al, 1999; Wadhams and Davis, 2000; Yu et al, 2004. The upper limit should be raised to 43% for summer, with the 32% beiung a year-round figure. (Peter Wadhams, University of Cambridge)	
15-375	A	7	31	7	33	I didn't follow the relevance of this point. Is this to say that thickness measurements are somewhat problematic because of advective redistribution of sea ice? (David E Atkinson, University of Alaska Fairbanks)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-376	A	7	31	7	33	A poorly written sentence and should be substantiated e.g. there is some evidence of a potential build up of ice along the north Canadian coastline driven by changes in wind and ocean curent patterns (Fiona Cawkwell, University of Alberta)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-377	A	7	31	7	33	rephrase and tie in to previous sentence (Peter Johnson, University of Ottawa)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-378	A	7	31			Sentence beginning with “Although …” doesn’t seem to add anything and could be removed. (Ian Joughin, Applied physics Lab, University of Washington)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-379	A	7	31	7	33	This sentence is unintelligible. (Peter Lemke, Alfred Wegener Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-380	A	7	31	7	33	This sentence could be misinterpreted as calling into question both the ice retreat and the ice thinning rates mentioned in the preceding few sentences. To avoid that, I recommend changing "Although, the importance ..." at the start of the sentence to: "However, the thickness measurements are spatially quite incomplete, and the importance ..." (Claire Parkinson, NASA Goddard Space Flight Center)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-381	A	7	31			other references to problems with estimates of thinning sea ice include Melling et al (2005 - GRL) and Belchansky (2005 GRL v. 32) (Steven Solomon, Geological Survey of Canada)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-382	A	7	31	7	33	The sentence beginning "Although" is not a sentence but a subordinate clause. I also do not agree that the importance of advective redistribution is well-established. Again, you are basing yourself on the work of Holloway and Sou who are in a minority (of themselves alone) in advocating this effect, which is not supported at	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.

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						all by submarine or altimeter data. This shouold be toned down to something like "Advective redictribution may play a role". (Peter Wadhams, University of Cambridge)	
15-383	A	7	33	7	34	I suggest you add a sentence on polynyas as they are a very important part of arctic marine systems - something like. Polynyas (area of open water when one when expect sea ice) show a complex response to climate change. The North water polynya appears to becoming more like a marginal ice zone (Barber et al. 2001) while the Cape Bathurst Polynya has expanded in size and moved location through an eastward expansion (Barber and Hanesiak, 2004). Polynyas are a focal point for studies examining physical-biological coupling. (David Barber, University of Manitoba)	JW: Suggested sentences and reference (Barbaer and Hanesiak, 2004) have been inserted in Section 15.4.3.1, first paragraph.
15-384	A	7	34	7	36	What is the estimated contribution to sea level rise from the Alaskan glaciers (Fiona Cawkwell, University of Alberta)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I. The requested information is in WG I's Table 4.5.3.
15-385	A	7	34	7	34	This statement can be supported with numbers from recent work by Sharp et al that is currently in review of a decline in ice covered area in Queen Elizabeth Island archipelago of 2.7% between 1960 and 2000 (Fiona Cawkwell, University of Alberta)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-386	A	7	35			"Alaskan glaciers"? Should this not be glaciers of Alaska and the Yukon Territory? (John Streicker, Yukon College)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-387	A	7	37	7	39	A reference is needed here. Dowdeswell et al., 1997 might be used as a ref for the 1960s to 1990s period. You might have to look into the grey literature for a ref to the changes during the last few years (Elisabeth Isaksson, Norwegian Polar Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-388	A	7	37	7	37	Again, should refer to ACIA, 2005. (Michael MacCracken, Climate Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-389	A	7	37			The contribution of glacial melt to rising sea level has been questioned in a paper by Wadhams and Munk (2004). Reference is Wadhams, P and W Munk (2004). Ocean fresheninjg, sea level rising, sea ice melting. Geophysical Res Letters,. 31(11), L11311, doi:10.1029/2004GL020039. In this paper it is shown that the rate of melt of Arctic sea ice is such as to produce enough fersh water to account for nearly all the freshening of the ocean observed in the census hydrography studies of Levitus and colleagues. Melting of sea ice produces no sea level change. This means that the eustatic rise in sea level due to run off from glaciers is small, only	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I. The linkage between glacial melt and sea level is addressed quantitatively in WG I's Chapter 4, Section 4.8.2 – see their Table 4.5.3.

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						0.6 mm/yr, while the steric rise due to heating is larger. The small eustatic rise means that the runoff from glaicers must be almost balanced by freezing elsewhere, eg thickening of the Antarctic ice sheet. (Peter Wadhams, University of Cambridge)	
15-390	A	7	38	7	38	…increased precipitation, but their mass balance … (Peter Lemke, Alfred Wegener Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-391	A	7	38		41	It is probably important to indicate here that there is possibly thickening at high elevations (Johannessen OM et al., Recent Ice-Sheet Growth in the Interior of Greenland, Scienceexpress, 10.1126/science.1115356, 2005) – so that we probably don't know the sign of Greenland mass balance. (Tavi Murray, University of Wales Swansea)	JW: These results and the reference to Johannessen et al. (2005) have been inserted in Section 15.2.1, 4th paragraph.
15-392	A	7	39	7	39	Would read better if change "is" to "has been" (Michael MacCracken, Climate Institute)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I.
15-393	A	7	39	7	41	This is stating the obvious - the low elevation zones of the Greenland ice sheet are in the ablation zone, so of course the mass balance is negative. The question is whether it is becoming more negative with respect to time. (Martin Sharp, University of Alberta)	JW: In the new 4th paragraph of Section 15.2.1, the text now states that the Greenland ice sheet is thickening in the interior (Johannessen, 2005) but thinning at the periphery, where summer melt has increased during the past 20 years (Abdalati and Steffen, 2001). If there is thinning at the periphery, then the mass balance is becoming more negative than in the past.
15-394	A	7	39	7	41	Here, the comment on summer melt of Greenland should be more specific than "increased irregularly….". From the ACIA report the following result has been found: "The area of the Greenland ice sheet that experiences some melting has increased about 16% from 1979 to 2002. The area of melting in 2002 broke all previous records (ACIA, 2004). (Jan-Gunnar Winther, Norwegian Polar Institute)	JW: This entire paragraph has been deleted because it is more appropriate to WG I. However, we have added a few sentences about the Greenland mass balance (Section 15.2.1, 4th para.) citing the results of ACIA (Walsh et al., 2005), Johannessen et al. (2005) and Abdalati and Steffen (2001)..
15-395	A	7	39	7	41	A recent work by Johannessen et al. (Science, Oct. 2005) report that the interior of the Greenland ice sheet has gained mass that more than compensates for the loss of mass at the margins. The study is based on ERS satellite data from 1992-2002. (Jan-Gunnar Winther, Norwegian Polar Institute)	JW: New paragraph (Section 15.2.1) cites Johannessen et al. (2005) and summarizes their findings.
15-396	A	7	40	7	41	The mass balance of Canadian Ice Caps and glaciers have also been written about	JW: This entire paragraph has been deleted –

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						by Abdalati et al. (2004) and all the Arctic land Ice Masses by Dowdeswell et al. (1997) . These references as well as the Koerner work should be used. The Abdalati et al. paper on the Canadian Arctic shows the Canadian Ice Masses are decreasing in agreement with the Koerner mass balance series over the same interval. And how about a figure or map from one of these papers; they are quite good summarizers. Maybe the authors decided not to use any paleo records but there are some that are so simple as to defy wrong interpretation. For example, the melt layer records from Agassiz Ice Cap (Ellesmere Island) show the last 100 years has had summer melt at a level higher than any over the last 2500 years (Koerner and Fisher, 2003). (David Fisher, Geological Survey of Canada)	material is more appropriate to (and is covered by) WG I. In particular, In particular, CG I's Chapter 4, Section 4.5.2 cites Abdalati et al.'s (2004) paper on Canadian Arctic ice masses.
15-397	A	7	41			I would suggest to quote the review paper of Rignot and Thomas printed on Science 2002 (Massimo Frezzotti, ENEA)	JW: This entire paragraph has been deleted – material is more appropriate to (and is covered by) WG I. In particular, Chapter 4 of WG I cites the paper of Rignot and Thomas (2002).
15-398	A	7	42			a further valuable reference to the documented changes in northern (and other) regions associated with climate change is the comprehensive review of Walther, G.-R., Post, E., Convey, P., Parmesan, C., Menzel, M., Beebee, T.J.C., Fromentin, J.-M., Hoegh-Guldberg, O. & Bairlein, F. (2002) Ecological responses to recent climate change, Nature 416, 389-395. (Peter Convey, British Antarctic Survey)	JW: Reference has been added at the end of 3rd paragraph of Section 15.2.1.
15-399	A	7	42			Add a brief para noting that recently the Greenland Ice Sheet has thickened at higher elevations (above 1500 m) but shrunk at lower elevations. Overall the ice sheet is apparently growingt [Johannessen et al. 2005. Recent Ice-Sheet Growth in the Interior of Greenland, published online October 20 2005; 10.1126/science.1115356 (Science Express Reports)] (Indur Goklany, Office of Policy Analysis, Department of the Interior)	JW: This has been done in the new 4th paragraph of Section 15.2.1, in which the text now states that the Greenland ice sheet is thickening in the interior (Johannessen, 2005) but thinning at the periphery, where summer melt has increased during the past 20 years (Abdalati and Steffen, 2001). If there is thinning at the periphery, then the mass balance is becoming more negative than in the past.
15-400	A	7	42	7	43	Would read better saying "Reductions of the … are also consistent with recent arctic warming." (Michael MacCracken, Climate Institute)	JW: Sentence has been restructured as suggested.
15-401	A	7	42	7	46	Over wat time period is warming of permafrost observed - since the 1980s which is the period over which most of the measurements occur. Regarding measurements	JW: Both suggested changes have been made in the revised text.

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						of active layer- it would be more correct to say that long-term systematic measurements are lacking as there is a program designed to provide systematic measurements of active layer. (Sharon Smith, Geological Survey of Canada)	
15-402	A	7	43	7	46	Michel Allard and co-workers at the Centre d'etudes nordiques, Universite Laval, have done quite a bit of work on air and ground temperatures across Nunavik, as well as modelling of permafrost response to climate change (e.g. Buteau, S., Fortier, R., Delisle, G., Allard, M., 2004. Numerical simulation of the impacts of climate warming on a permafrost mound. Permafrost and Periglacial Processes, 15: 41-57). Contact Michel Allard (michel.allard@cen.ulaval.ca) for more information. (Philip Hill, Geological Survey of Canada)	JW: The paper by Buteau is a single-point modelling study (for a permafrost mound), and not the type of spatially distributed study that would fit as a reference. We searched for refereed publications of Allard on permafrost changes in Nunavik, but could not find any that are refereed. As an alternative response, we added ro Euskirchen et al. (2006) and Sazanova et al. (2004) – cf. 3rd paragraph of Section 15.3.4.1.
15-403	A	7	45	7	46	See above. Visual evidence of permafrost degredation caused by what? The reader again gets the impression that this is caused by the observed warming trend, which I found difficult to accept based on thermal calculations. (Arne Instanes, OPTICONSULT Consulting Engineers)	JW: Visual evidence is visual evidence, regardless of the cause. Nevertheless, we do address the reviewer's concern in Section 15.7.1, para. 2, beginning with the sentence "An important challenge facing climate-change science is discerning between the effects of climate change on permafrost and more localized, human-induced changes {Nelson, 2003 #435}."
15-404	A	7	47	7	47	"a transition from grasses to shrubs". It is an oversimplification to assert that the increases in abundance of larger shrubs (e.g. Alnus, Salix) described by Sturm et al. (2001) come at the expense of 'grasses'. Documented increases in smaller shrubs (e.g. Betula nana) in northern Alaska have come at the expense of aquatic sedges (e.g. Eriophorum vaginatum) (Chapin et al. 1995). Meanwhile, in neighboring northern Yukon Territory, Canada, the cover of Polargrass (Arctagrostis latifolia) has actually increased in upland tundra (Kennedy et al. 2001). Also, the situation in northern Russia is complex. According to indigenous reindeer herders my colleagues and I have been working with for the past few years, some areas appear to be experiencing increasing shrub abundance, while others have become graminoid dominated because of extensive anthropogenic disturbance, so-called 'grassification' (see e.g. Shchelkunova 1993). Even in the northern Alaska habitats actually depicted in the airphotos reviewed by Sturm et al. (2001), the prevailing tussock tundra should not be generalized as 'grasses'. References: Shchelkunova, R.	TVC: all this is probably due to wording – I will consider re-wording but cannot go into the suggested detail due to space limitations.

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						P. (1993) The effect of industry and transport on reindeer pastures: the example of Taymyr. Polar Geography and Geology 17: 252-258; Chapin, F.S. III., G.R. Shaver, A.E. Giblin, K.J. Nadelhoffer, and J.A. Laundre (1995) Responses of arctic tundra to experimental and observed changes in climate. Ecology 76: 694-711; Kennedy, C. E., C.A.S. Smith and D.A. Cooley (2001). Observations of change in the cover of polargrass, Arctagrostis latifolia, and arctic lupine, Lupinus arcticus, in upland tundra on Herschel Island, Yukon Territory. Canadian Field-Naturalist 115: 323-328. (Bruce Forbes, University of Lapland)	
15-405	A	8	3	8	3	insert the word "now" to read "The Arctic is now…" (Josefino Comiso, NASA Goddard Space Flight Center)	JW: "now" has been inserted. (This sentence appears in Section 15.2.2.4, para. 2).
15-406	A	8	3	8	5	This reference to 4 million population and the indigenous fraction topic also comes up on p 15 line 4 and on p 39 line 12. (James McCarthy, Harvard University)	JW: We retained the later reference (FOD p. 39) and deleted the earlier one.
15-407	A	8	4	8	5	change phrase that starts with "increased…" to "the increase in the population of non-indigenous have surpased those of indigenous inhabitants." (Josefino Comiso, NASA Goddard Space Flight Center)	CF-accepted
15-408	A	8	5			Chapter 15.2.1 Climate, environment and socio-economic state; Give the numbers of indigenous inhabitants living in the Arctic (8% of 4 million people). (Geir Wing Gabrielsen, The Norwegian Polar Institute)	CF-considered, demographics included as is, space (possible table addition to show pops to be considered)
15-409	A	8	8	8	37	This is one section that could be reduced in length e.g. changes in community infrastructure and availability of tobacco are not related to climate change (Fiona Cawkwell, University of Alberta)	CF-accepted, CF to edit
15-410	A	8	8	40	42	This paragraph should indicate that much of the Arctic's pollution is produced outside of the Arctic's borders and carried to the region by transboundary winds, etc. One might read the present paragraph as suggesting that most contaminant production takes place in the Arctic itself. (Marybeth Long Martello, Harvard University)	CF-accepted, consider length though
15-411	A	8	8	3	42	How do these socioeconomic factors discussed on this page relate to sensitivity and vulnerability? Why were these factors (e.g. migration, demographics, administration, etc.) singled out? For example, (lines 13-16), what, specifically, are the negative affects of residence in fixed villages? How do negative effects on subsistence lifestyles shape sensitivity and vulnerability? Is movement to fixed-villages, making residents/communites more sensitive? This same question could also be applied to discussion of changes in community infrastructure, fertility relates, self-government, mixed economies, etc.. It is not clear how these topics relate to climate change and to the sensitivity and vulnerability. These connections	# We note that we still have a vacancy for a CA on socio-economics.

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						should be made more explicit. (Marybeth Long Martello, Harvard University)	
15-412	A	8	8	39	42	Again, this paragraph should indicate why the growing role of the Arctic in global politics and economies is important in understanding climate change impacts, and, in particular, sensitivity and vulnerability. However, while POPs politics is certainly an excellent example of Arctic prominence in global politics and economies, it is by no means the only one. So why is it singled out? What about oil and gas development, pan-Arctic cooperation on a number of sustainable development issues, the activism of Indigenous Arctic Peoples on climate change, etc? (Marybeth Long Martello, Harvard University)	CF-Singled out because it is in the ref from Oran Young in AHDR. It is one for which there is evidence of cooperation globally (Stockholm Convention etc). Cannot expand much to make this point due to length restrictions. Comment accepted and considered in edits.
15-413	A	8	10	8	10	Is it "fair" to give the population density for a political area that is so small? It is presented as the end of a spectrum, however were you to give density values for all arctic areas I imagine most of them would be low and the Faroes would represent a bit of an outlier. (David E Atkinson, University of Alaska Fairbanks)	CF-yes, density is important for many things, including factors or elements of capacity and geographic distribution of vulnerability.
15-414	A	8	10			The figure for the population density for the Faroe Islands looks wrong. In Wikipedia the density for the Faroe Islands is 33 per km2. 3410 per km2 is greater than the value in Wikipedia for Los Angeles. (Lloyd Peck, British Antarctic Survey)	CF-I would trust AHDR, that is what is referenced.
15-415	A	8	10	8	13	In the Canadian north there are many small communities with population <5000 (Sharon Smith, Geological Survey of Canada)	CF-Text was cut that stated this, will revisit and accept.
15-416	A	8	12	8	12	Change "others" to "other countries" (Michael MacCracken, Climate Institute)	CF-accepted
15-417	A	8	14	8	16	An assertion like this requires a reference or a justification/explanation in the text. (Philip Hill, Geological Survey of Canada)	CF-accepted, to add reference.
15-418	A	8	15	8	16	The permanent establishment of infrastructure at indigenous habitations has also led to the problem of coastal erosion affecting their settlements in ways that had not happened before. Should this be added into the examples of negative impacts, along with exercise and diet? (David E Atkinson, University of Alaska Fairbanks)	CF-to review and consider. Accepted.
15-419	A	8	16	8	20	The wording here almost makes it sound like providing safe water and hospitals is just as detrimental as increasing access to tobacco and alcohol. (Ian Joughin, Applied physics Lab, University of Washington)	CF-No, misinterpretation by reader. It is clearly stating changes in the nature and infrastructure of communities. No change made.
15-420	A	8	17			increase in demand for' or 'increase in safe water supply' (Peter Johnson, University of Ottawa)	CF-to clarify

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15-421	A	8	19			are the Faroe Islands really included in the definition of the Arctic? (Peter Convey, British Antarctic Survey)	CF-accepted, edited definition being inserted in the front of chapter.
15-422	A	8	19			"and" should be "an" (Robert Thomas, EG&G Services)	CF-accepted.
15-423	A	8	21	8	24	Reference required (Philip Hill, Geological Survey of Canada)	CF-AHRD reference to be added. Accepted.
15-424	A	8	21	8	24	It is, however, important to note whether the arctic population in general or the indigenous fraction is being referred to in the comments in this section. (James McCarthy, Harvard University)	CF-Accepted, edited.
15-425	A	8	22			Do we mean fertility here. Is the data showing more sperm produced by males and that it is easier for females to become pregnant, or is it just that these populations have more offspring which may be due to variations in use of contraception. (Lloyd Peck, British Antarctic Survey)	CF-to revise – we are speaking of fertility as defined: "The childbearing performance of individuals, couples, groups, or populations--that is, the number of births they have." As defined by US National Centre For Health Stats…
15-426	A	8	24			Chapter 15.2.1 Climate, environment and socio-economic state; Give a reference at the end of the sentence (Geir Wing Gabrielsen, The Norwegian Polar Institute)	CF-AHDR to be added as ref here
15-427	A	8	24			change "has" to "have" (Laurence C. Smith, University of California, Los Angeles (UCLA))	CF-accepted
15-428	A	8	28			regions of self-government are Nunavut, Northwest Territories, Yukon and Greenland. I realize you are just citing examples, but I note that the two examples you have listed are Inuit peoples, while the two regions you missed are (largely) Athabaskan peoples. There is a concern that these people are sometimes missed on these issues. (John Streicker, Yukon College)	CF-Comment on balance among regions taken. To edit.
15-429	A	8	28			Some regions (e.g. Nunavut, Greenland, AND ALASKA) (Gunter Weller, University of Alaska)	CF-accepted
15-430	A	8	31	8	32	This applies to communities in North America and Greenland, and to some extent to Northern Russia. The Scandnavian countries are overwhelmingly market economy oriented with little or no subsistence. (Alf Håkon Hoel, University of Tromsø)	CF-correct, accepted and edited.
15-431	A	8	40			Contaminant production… If read literally, this suggests contaminant productions is a good thing since it has been essential to… Change to something like "Recognition of contaminant production…". (Ian Joughin, Applied physics Lab, University of Washington)	CF-accepted.
15-432	A	8	40			The phrase "Contaminant production and use…" is not clear	CF-accepted, clarified in edits.

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						(Vladimir Romanovsky, University of Alaska Fairbanks)	
15-433	A	8	41			Chapter 15.2.1 Climate, environment and socio-economic state; Give the reference to the AMAP Human Health Report (2002) (Geir Wing Gabrielsen, The Norwegian Polar Institute)	CF-No. AHDR and Downey and Fenge book are references that talk of the Stockholm Convention in this sense, not the AMAP report.
15-434	A	8	41	8	42	Sentence does not make sense (Robert Thomas, EG&G Services)	CF-accepted, edited.
15-435	A	8	42			Reference should be to Downie and Fenge (Peter Johnson, University of Ottawa)	CF-correct, reference was truncated in editing. DGV ??
15-436	A	8	44			15.2.1 (Antarctic) No information about changes of sea ice extent and icebergs population in the Southern Ocean. There is no information about changes in marine environment in the Southern Ocean. No information about increasing of precipitation. There is too much well known general geographical information about Antarctic. (Vladimir Pavlov, Norwegian Polar Institute)	# DGV, The FOD does have information on sea ice changes, but none on icebergs #DGV to add comment about Davis paper We believe that this is required to make it accessible to the widest audience.
15-437	A	8	45	10	2	Need to mention that socio-economic consequences of climate change in Antarctic are different than Arctic - lack permanent human population, resource development etc. (Sharon Smith, Geological Survey of Canada)	# DGV – I think that this is made reasonably clear elsewhere
15-438	A	8	48	8	49	katabatic winds flowing "off" the continent tend to be relatively very warm, not cold. (Peter Doran, University of Illinois at Chicago)	# DGV – Accepted
15-439	A	8	50	8	50	replace "steep slopes" with "bedrock exposures"??? (Jerry Brown, International Permafrsot Association)	# DGV - Accepted
15-440	A	8	50	8	50	add "polynyas" to read "coastal oases or polynyas" Polynya is a more popular term for scientists (Josefino Comiso, NASA Goddard Space Flight Center)	Disagree – “polynyas” refers to an area of sea free of sea ice, here we are talking about land areas free of ice sheet.
15-441	A	9	2			Mean (?) summer temperatures (Robert Jefferies, University of Toronto)	No, we intended this to refer to occasional summer melting events, and so does not imply mean temperatures.
15-442	A	9	4	9	5	rewrite as "where solar heating of exposed rocks produces a little moisture." (Josefino Comiso, NASA Goddard Space Flight Center)	# Accept
15-443	A	9	7	9	14	This discussion does not cover the full breadth of the published analysis of climate	# This comment needs careful response.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						trends for continental Antarctica, and I think it is misleading in that it seems to cover only studies that conclude that the Antarctic continent is warming. This is not in the spirit of the IPCC. Turner et al 2005 and Vaughn et al 2003 (both British Antarctic Survey contributions) are the only two citations for this very important topic. These papers look at the individual station data as single point measurements, and really find no trend to speak of outside of the Peninsula. Yet this paragraph and the summary of it up front, lead the reader to the conclusion that there is a slight warming trend on the continent. This is controversial, and yet this controversy is not indicated here. Doran et al 2002 (in chapter reference list) take a more spatial approach to analyzing the data and found that more area of the continent cooled rather than warmed from 1966-2000. This result was challenged by Vaughan and Turner in the literature, and now that seems to mean this result does not get discussed here. Vaughan has referred to the analysis of Doran et al in the literature as “flawed”, but we stand by the results as expressed in our response in Nature to their concerns (Walsh et al, 2000 Nature 418 (6895): 292-292). Nevertheless, widespread continental cooling from 1971-2000 is reported by Turner et al., yet that result is not discussed here. Why is there no coverage here of important papers that discuss recent cooling trends on the continent? For example: Comiso, 2000 J. Climate 13:1674-1696 with satellite (AVHRR) data shows a result similar to Doran et al (as far as spatial extent of cooling vs warming) for data from 1979 to 1998 Kwok and Comiso 2002, GRL VOL. 29, NO. 14, 10.1029/2002GL015415, 2002 show a dominance of cooling on the continent between 1982 to1998 based on the AVHRR satellite record. A shorter record than the station data, but far more spatially representative Thompson and Solomon 2002, Science 296: 895-899 show ubiquitous continental cooling in the station data from 1969 to 2000 and attribute it to a high index polarity of the Southern Annular Mode, and suggest a link between the temperature trends and decreasing stratospheric ozone. The connection between the trends seen in Antarctic surface temperatures and	And in general we agree that more should be made of the patchiness in temperature change in the Antarctic.

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						stratospheric ozone is conspicuously missing here and elsewhere in this chapter. There are two papers that I think are very important to have included in this report: Gillette and Thompson, 2003 Science 302:273-275 model the strong connection between ozone levels and temperature in Antarctica. They conclude that emissions of ozone-depleting gases have had a distinct impact on climate in the stratosphere and on the ground. Shindell and Schmidt 2004 GRL 31 L18209 doi:10.1029/2004GL020724 model the combined impact of ozone levels and greenhouse gases on past and future climate in Antarctica. They show that the ozone and greenhouse gas levels are forcing the climate in different directions right now, but as the ozone hole heals in the next 50 years, temperatures in Antarctica will start to rise dramatically as the greenhouse gases start to dominate (Peter Doran, University of Illinois at Chicago)	
15-444	A	9	7	9	14	The paleo temperature records for the southern hemisphere would be very useful here because they demonstrate over longer time periods what the authors say, namely that making an average temperature series for the Antarctic does not show very much because the natural regional differences are larger than in the arctic. (There are a number of refs that could be cited, let me know if you want any). (David Fisher, Geological Survey of Canada)	This is a reasonable point but I am not sure that there is room to fit it in.
15-445	A	9	7	9	14	I suggest to include information about climate changes in the ocean west of the Antarctic Peninsula by Meredith and King (2005)(Michael P. Meredith and John C. King (2005) Rapid climate changes in the ocean west of the Antarctic Peninsula during the second half of the 20th century. Geophys. Res. Lett., vol.32, L19604, doi:10.1029/2005GL024042). (Vladimir Pavlov, Norwegian Polar Institute)	# This paper was published after the FOD was completed, and will now be considered for the Second-order draft.
15-446	A	9	8	9	10	How strong is warming? Need figures. (Vladimir Pavlov, Norwegian Polar Institute)	This material is better presented by WGI
15-447	A	9	9	9	9	Not clear what "other long-term records" means if they are not meteorological stations… (Philip Hill, Geological Survey of Canada)	#Reword to clarify
15-448	A	9	11	9	11	"only two of these" is not well-defined--two of which? (Michael MacCracken, Climate Institute)	#Reword to clarify
15-449	A	9	11	9	11	For the sake of being crystal clear, change "one of each" to "one warming, one cooling".	#Reword to clarify

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Claire Parkinson, NASA Goddard Space Flight Center)	
15-450	A	9	11	9	14	The following sentence is suggested added in line 14: Recently, Liston and Winther (2005) reported that near-surface snow melt constitutes a substantial portion of the annual mass balance in the coastal areas of Antarctica. Full reference: Liston, G.E. & Winther, J-G., 2005: Antarctic surface and sub-surface snow and ice melt. J. Climate 18 (10), 1469-1481. (Jan-Gunnar Winther, Norwegian Polar Institute)	We have checked, and this is an interesting paper but we do not agree that it is appropriate to cite it here.
15-451	A	9	13	9	14	replace phrase starting with "but there.." with "while there is no evidence of a ubiquitous "polar amplification" in Antarctica as observed from satellite data (Comiso, 2002). (Josefino Comiso, NASA Goddard Space Flight Center)	#Reword to clarify
15-452	A	9	13	9	14	Instead of saying "there is no evidence of a ubiquitous 'polar amplification' in Antarctica", it should instead be said that there might even have been a cooling over much of the continent. See, e.g., Vaughan et al., Science, 293, 1777, 2001, and the references therein. (Claire Parkinson, NASA Goddard Space Flight Center)	There was certainly not a cooling over the whole continent but perhaps it is worth pointing out that some areas of cooling may have taken place
15-453	A	9	14	9	14	Why is there no polar amplification in Antarctica? Is there a good physical explanation to this? (Arne Instanes, OPTICONSULT Consulting Engineers)	WGI issue
15-454	A	9	14			It is not clear why the polar amplification is "ubiquitous". The processes that result in it happening in the North do not apply in the same way to the south. What do the models show? As long as Antarctica remains very cold, but warmer, the melting snow-albedo effects, role of sea ice and insultating a warm ocean near the pole, ... do not apply. (Gordon McBean, University of Western Ontario)	It is not ubiquitous! And this was stated.
15-455	A	9	14			If the chapter is running long, then my suggestion is to drop some of the Antarctic discussion. I respect all of the scientific work that is going on at the South pole. Still you state early on in the chapter (page 9 line 14) that there is no overall polar amplification, therefore the results while important and informative, have less consequence. (John Streicker, Yukon College)	The Antarctic discussion is already at a minimum to provide reasonable balance, and it would not be realistic to ignore such an entire continent in a “global report”
15-456	A	9	16	9	20	Shouldn't this discussion of terrestrial ecological impacts appear on page 12 in the Antarctic section of 15.2.2.1 ? (Peter Doran, University of Illinois at Chicago)	Will consider this.
15-457	A	9	19			have' not 'has' (Peter Johnson, University of Ottawa)	#Reword to clarify

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15-458	A	9	19			Signy Island is not sub-Antarctic. It lies south of 60°S, and is thus inside the Antarctic circle. Also all the major works on biogeographic zones put it firmly in the maritime Antarctic, which lies to the south of the sub-Antarctic zone (see Longton, 1988, Cambridge University Press, Cambridge, or Peck et al. In Press, Biological Reviews). Also Lakes on Signy Island warmed by 0.9°C in 15 years not 1°C in 25. (Lloyd Peck, British Antarctic Survey)	# The Antarctic Circle is 66° 33' 39" and not 60, which means that by physical sciences' definition Signy is not Antarctic. However, biologists appear to have problems with this and prefer to use "maritime Antarctic" to describe these islands. A form of words to express this will be used. We may simply drop both of these terms # Noted
15-459	A	9	19			Sentence needs revising, unclear grammar re Signy Island. (Ted Scambos, University of Colorado)	#Reword to clarify
15-460	A	9	19			"has" should be "have" (Robert Thomas, EG&G Services)	#Reword to clarify
15-461	A	9	20			while the Quayle et al 2002 reference is appropriate, considerably more detail on the effects, chemical and biological consequences is given in Quayle, W.C, Convey, P., Peck, L.S., Ellis-Evans, J.C., Butler, H.G. & Peat, H.J. (2003) Ecological responses of maritime Antarctic lakes to regional climate change. In: Antarctic Peninsula Climate Variability: Historical and Palaeoenvironmental Perspectives, eds. E. Domack, A. Burnett, A. Leventer, P. Convey, M. Kirby & R. Bindschadler, pp. 159-170. Antarctic Research Series vol. 79, American Geophysical Union. (Peter Convey, British Antarctic Survey)	The cited reference was the first publication of the results and is already highly-cited and we wish to make reference to that paper.
15-462	A	9	26	9	28	This statement would be more accurate if it were reworded as follows: "As a result the draw-down of CO2 and the rate of new production is actually lower with diatoms than with Phaeocystis, and increased stratification would lead to diminished draw-down of atmospheric CO2 and its transport to the deep ocean" (James McCarthy, Harvard University)	# Accept
15-463	A	9	27	9	30	These two sentences seem inconsistent. Which is right? (Gordon McBean, University of Western Ontario)	Will consider revision
15-464	A	9	30	9	30	Assume you mean increasing concentrations of CO2. (David E Atkinson, University of Alaska Fairbanks)	#Reword to clarify
15-465	A	9	30	9	38	Example of text on feedback that could be left to WG1. (Philip Hill, Geological Survey of Canada)	Noted
15-466	A	9	30	9	47	The same problems as mentioned here exist in the Arctic region, but is not mentioned (cf. Page 8) (Annika Hofgaard, Norwegian Institute for Nature Research)	Noted

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15-467	A	9	30	9	38	I don't think this section (as a whole) makes sense as written. Also, would forams and coccoliths normally be considered microbes? (Martin Sharp, University of Alberta)	#Reword to clarify
15-468	A	9	31			seawater IS becoming more acidic... (Laurence C. Smith, University of California, Los Angeles (UCLA))	#Reword to clarify
15-469	A	9	33	9	35	Something missing in this sentence (Fiona Cawkwell, University of Alberta)	#Reword to clarify
15-470	A	9	33	9	38	This is an important section. At present the statements are too cryptic to follow clearly. I suggest that the section is expanded. It is not clear whether elevated/decreased C02 concentrations refer to the oceans or the atmosphere in all cases. Also the nature of the feedbacks are not clear. (Robert Jefferies, University of Toronto)	Section to be revised.
15-471	A	9	33	9	35	Something is missing from this sentence (James McCarthy, Harvard University)	#Reword to clarify
15-472	A	9	33	9	35	Looks like some part of this sentence is missing (Vladimir Romanovsky, University of Alaska Fairbanks)	#Reword to clarify
15-473	A	9	34			incomplete sentence (John Calder, National Oceanic and Atmospheric Administration)	
15-474	A	9	34			same note; something wrong with sentence; I think it is supposed to be 'sinking _is_ the draw-down of atm. CO2 into the deep...' (Ted Scambos, University of Colorado)	#Reword to clarify
15-475	A	9	34			sentence does not make sense. "..sinking IS" instead of "IN?" (Laurence C. Smith, University of California, Los Angeles (UCLA))	#Reword to clarify
15-476	A	9	37	9	38	This sentence needs reconstruction. Calcification does not release CO2 to the atmosphere, it removes it. (Lloyd Peck, British Antarctic Survey)	#Reword to clarify
15-477	A	9	39			Start a new paragraph with “Fishing…” , 9-30 through 9-38 can probably be merged with the previous paragraph. (Ian Joughin, Applied physics Lab, University of Washington)	Accept
15-478	A	9	43			Give Latin binomial of the Patagonian toothfish. (Robert Jefferies, University of Toronto)	Will refer to house style on this one
15-479	A	9	46			All species of albatross and petrel in the southern ocean? (Robert Jefferies, University of Toronto)	#Reword to clarify
15-480	A	9	47			their' should be 'the' ? or remove 'following' and a few other words? (Ted Scambos, University of Colorado)	Accept
15-481	A	9	49			it would be appropriate in this para to recognise the associated danger of accidental transport of non-indigenous species as one of the major risks associated with	Accept – if space permits

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						increased human contact with the Antarctic (see Frenot et al., details above). (Peter Convey, British Antarctic Survey)	
15-482	A	9	49	9	50	Chapter 15.2.1 Climate, environment and socio-economic state; There is also an increase in the number of tourists to the Svalbard area. In a 10 year time period the (1994 to 2004) the number of landings in the Svalbard area has increased from 50 to 150 (maily east of Svalbard) and the number of tourists has increased from 20 000 to more than 40 000 (The Norwegian Polar Institute 2005). (Geir Wing Gabrielsen, The Norwegian Polar Institute)	This may be true but is not appropriate here. The Antarctic tourism is mentioned firstly because it is the the most important economic activity on the continent and so deserves special mention, and, secondly, the rate of increase in Antarctic tourism is very rapid.
15-483	A	9	49	10	2	The Antarctic "State of Environment" reporting system could be mentioned here (ref: Belbin et al. 2003, State of environment reporting: an Antarctic case study, Polar Research 39: 193-201) (Annika Hofgaard, Norwegian Institute for Nature Research)	It is not clear to us **why** the reviewer says that this should be reported here. It is not clear that this is significant enough to warrant reporting here.
15-484	A	10	1	10	2	reference to WWF code for ecotourism (Peter Johnson, University of Ottawa)	The IAATO code is more specifc than the WWF one, and is the one which most Antarctic tour operators are practice
15-485	A	10	5	16	8	The sections in 15.2.2 do not mirror those in section 15.4. It would seem logical to me to do so. (Philip Hill, Geological Survey of Canada)	Issues in the Arctic and Antarctic are not similar and so these sections do not neccessailry mirror one another.
15-486	A	10	5			This section is titled "Vulnerability and Adaptive Capacity." However, the section lacks a discussion of these terms and how they lend a structure the text that follows. An introductory, explanatory discussion should be added. See above comment for dropping Section 15.2. (Marybeth Long Martello, Harvard University)	TVC – difficult to understand the point but I will check it DGV – definitions of these terms must be given for the entire volume, and cannot be specific to this chapter.
15-487	A	10	7			Section 15.2.2.1 This section provides very limited information about marine ecosystem. No information on adaptive capacity of the marine ecosystem (Vladimir Romanovsky, University of Alaska Fairbanks)	Little is known, or published on this so we don't cover in detail
15-488	A	10	9			Section 15.2.2.1: generally the text in many places give the reader the impression that climate change = climate warming. In section 15.2.1 it is pointed out that there are large regional differences in climatic trend, but this is not taken through in section 15.2.2.1 (Annika Hofgaard, Norwegian Institute for Nature Research)	This section is background to detail given in section 15.4: there you will find the regional differences - no action
15-489	A	10	10	10	12	I know of no evidence for this statement. Sure, I would probably agree, but do we really know this? Many of these arctic terrestrial plant species are circumpolar, and some are found in mountain ranges well to the south. So, are they so specialized? Why do you say they are poor competitors? Is there any real evidence for this, or is this just assumed?	Yes there is evidence – reference inserted but no space for extra details

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						(Konrad Gajewski, University of Ottawa)	
15-490	A	10	10	10	47	These two paragraphs make many assertions that are not supported by references. (Philip Hill, Geological Survey of Canada)	References added
15-491	A	10	10	35	47	From where do these terms of arctic and sub-arctic derive? How are they defined? (Marybeth Long Martello, Harvard University)	Definition added earlier in the text
15-492	A	10	10	9	12	I do not understand why a species that has adapted to harsh conditions is likely to be a poor competitor compared to immigrants (Gordon McBean, University of Western Ontario)	References added: no space for extra text
15-493	A	10	14	10	16	After "habitat loss and fragmentation", add: ", all human-induced", to make it clear that these are additional human impacts. (Claire Parkinson, NASA Goddard Space Flight Center)	Accepted – text modified
15-494	A	10	15			Should add harvest pressure, which when combined with climate changes, devestated the cod fishery (Larry Hinzman, University of Alaska Fairbanks)	Noted
15-495	A	10	17	10	22	Again, is there any real evidence of this, or is this just speculation? In general, I find this chapter, or at least, the sections I read in more detail and nearer to my field of expertise, full of general statements like this, that may be true, but may not be. (Konrad Gajewski, University of Ottawa)	See 15 – 490
15-496	A	10	21			re snow cover effects on soil temperatures – see also Sokratov and Barry 2002, and Bartlett et al 200. Sokratov, S.A. and R.G. Barry. 2002. Intraseasonal variations in the thermoinsulation effect of snow cover on soil temperatures and energy balance. J. Geophys. Res., 107(D9-10), ACL 13 1-7. Bartlett, M. G., D. S. Chapman, and R. N. Harris 2004. Snow and the ground temperature record of climate change, J. Geophys. Res. 109, F04008, doi:10.1029/2004JF00022 (Roger Barry, University of Colorado)	Not the relevant place for these references so no action taken
15-497	A	10	22	10	22	(.e.g., lemmings: turchin and Gatzli, 2001 or Arctic Cod, Fortier et al. 200x) (David Barber, University of Manitoba)	Accepted – text modified
15-498	A	10	24	10	24	What is genetic adaptive capacity? Are you sure this statement is true? Doesn't it depend on genetic diversity, which has not been greatly studied? (Konrad Gajewski, University of Ottawa)	Sentence removed
15-499	A	10	28			comma needed after "cycles" (Robert Jefferies, University of Toronto)	Accepted – text modified
15-500	A	10	29	10	31	Might be helpful to name the species and amount of northward migration (forests advancing from the South sounds a bit dramatic, and almost Shakespearean!) (Fiona Cawkwell, University of Alberta)	Accepted – text modified, but no extra detail given as it is in section 15.4

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15-501	A	10	29	10	30	due to melting permafrost, and subsequent water logging, forests might move southwards (ref: Crawford, Jeffree & Rees 2003). Further, boreal species might move southwards as species migration will be strongly influenced by seasonality of temperature change (Crawford & Jeffree 2005, Northern climate and woody plant distribution, In: Orbaek., J. B., Tombre, I. M., Kallenborn, R., Heggseth, E. N., Falk-Petersen, S. & Hoel, A. H. (eds.) 2005. Arctic-Alpine Ecosystems and People in a Changing Environment. Environmental Challenges in Arctic-Alpine Regions. Springer Verlag, Berlin (in press). (Annika Hofgaard, Norwegian Institute for Nature Research)	This detail occurs later in section 15.4: however, the text has been softened
15-502	A	10	29	10	32	This statement over simplifies the situation. For example, there is evidence that in some regions fire has led to the southward movement of tundra. (Robert Jefferies, University of Toronto)	See 15 – 501 above
15-503	A	10	31	10	31	I'm not sure flooding of northern coastal wetlands due to sea level rise will be a particularly rapid or pervasive a change, given fairly slow rates of rise, complicating factors of isostatic rebound (eg Canadian. mainland north coast), and the fact that many coastal areas are bluffs. In this case, I think by far the more important "crowding" aspect will be encroachment of ecosystems from the south against ecozones that are fundamentally pinned against a northern coastline. (David E Atkinson, University of Alaska Fairbanks)	Accepted – text modified
15-504	A	10	33	10	33	The figure does not illustrate relocation. (Philip Hill, Geological Survey of Canada)	The comparison between the figures depicting present and future projected vegetation clearly depict relocation of some vegetation types: no action
15-505	A	10	33	10	33	"…likely to be similar to that in the past…." This have been questioned by many authors/scientists! (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-506	A	10	33			Start a new paragraph here. (Gordon McBean, University of Western Ontario)	This section to be revised entirely
15-507	A	10	34	10	47	In this paragraph, I would put this part (lines 34-47) first and then discuss the impending changes. This seems like a good descriptive lead in. (David E Atkinson, University of Alaska Fairbanks)	This section to be revised entirely
15-508	A	10	34			Start a new paragraph with "Arctic marine…" (Ian Joughin, Applied physics Lab, University of Washington)	This section to be revised entirely
15-509	A	10	37	10	47	I would argue that it would be appropriate to create a fifth marine ecosystem 'major zone' This would be for polynyas. We now know that the most productive volume of arctic ocean in the northern hemisphere is in fact the North Water Polynya. We also know that polynyas are have been sufficiently recurrent to allow large	This section to be revised entirely

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						populations of higher trophic levels to take advantage of the climatic and carbon benefits of these artcic 'oasis'. Polynyas occur throughout the circumarctic and each have a unique benefit physically and ecologically. A recent summary of Arctic and Antarctic Polynyas draws into focus the unique role which these ecosystems play at the local to regional scale (Smith and Barber, 2006). (David Barber, University of Manitoba)	
15-510	A	10	37	10	47	This is the level of detail that is really needed for all sections - if space permits! (Fiona Cawkwell, University of Alberta)	Not possible
15-511	A	10	37	10	37	insert after 70oN "and also the Sea of Okhotsk (44oN to 62o N), …" (Josefino Comiso, NASA Goddard Space Flight Center)	This section to be revised entirely
15-512	A	10	38			Is it true that the Bering Sea is characterized by relative stability over time? How about changes in recent decades, e.g. crashes in marine mammals and sea birds? (Gunter Weller, University of Alaska)	This section to be revised entirely
15-513	A	10	40			I suggest to remove the word “relatively” because on the page 12 (lines 3-4) it is mentioned that parts of the Bering and Barents seas are among the most productive in the world. (Vladimir Pavlov, Norwegian Polar Institute)	This section to be revised entirely
15-514	A	10	43			Start a new sentence between “commercial species” and “this area” (Ian Joughin, Applied physics Lab, University of Washington)	This section to be revised entirely
15-515	A	10	44	10	46	This sentence makes little sense. Does the reduced light exhibit lower productivity or cause it. (Gordon McBean, University of Western Ontario)	This section to be revised entirely
15-516	A	10	45			may be nutrient limited as well, meaning no increase in primary productivity with decrease in sea ice as the increase in stratification may indeed further limit nutrients. (Larry Hinzman, University of Alaska Fairbanks)	This section to be revised entirely
15-517	A	11	0			The color code is poor, making it difficult to distinguish between surface types and changes (Gunter Weller, University of Alaska)	Fixed
15-518	A	11	2			In the Figure 15.2 it is impossible to identify the vegetation class "Polar desert". A new pattern is needed! (Jefferson Cardia Simões, Instituto de Geociências)	Fixed
15-519	A	11	3	11	37	changes on these figures may be difficult to differentiate with these color coding and scale, Suggest one map and line showing change in boreal forest. Don't believe results in northern Alaska. (Jerry Brown, International Permafrsot Association)	Fixed

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15-520	A	11	48			need more precision than Siberia !! (Roger Barry, University of Colorado)	
15-521	A	11	52			how much contribution to sea level rise from Alaskan glaciers? (Roger Barry, University of Colorado)	Comment is misplaced Possibly more of the remit of WGI
15-522	A	12	3	12	5	This repeats the above sentence - but makes more sense. (Gordon McBean, University of Western Ontario)	Thanks
15-523	A	12	4			Chapter 15.2.2.1 Terrestrial and marine ecosystems; Is the reference to Sakshaug 2003 correct? I think that the correct reference is Sakshaug et al. 1994. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	We used the more up-to-date reference for preference.
15-524	A	12	5	12	6	What region are these yield values for? (Philip Hill, Geological Survey of Canada)	
15-525	A	12	11	12	12	It is cooler but warming? - be clearer. (Gordon McBean, University of Western Ontario)	Understood
15-526	A	12	11	12	13	The findings of Richardson and Schoeman only refer to very large phytoplankton - they did not sample the small, and most abundant species (James McCarthy, Harvard University)	Thanks
15-527	A	12	12			About 1/2 of primary production in ice covered seas comes from ice algae. If no sea ice, then no ice algae (Larry Hinzman, University of Alaska Fairbanks)	?
15-528	A	12	12	22	25	This paragraph appears to be more about sensitivity than adaptive capacity. Moving this material to the sensitivity section should be considered. (Marybeth Long Martello, Harvard University)	Thanks
15-529	A	12	12	44	49	The relevance of this paragraph to adaptive capacity is not clear. Please clarify the connection. (Marybeth Long Martello, Harvard University)	Ditto
15-530	A	12	12	3	9	How does the information presented in this paragraph relate to vulnerability and adaptive capacity? These connections should be made clear, or the paragraph deleted. Alternatively, does some of this material belong in the sensitivity section? (Marybeth Long Martello, Harvard University)	Ditto
15-531	A	12	15			the word "mismatch" does not give much meaning; I suggest a fuller discussion be given describing the things that are mismatched. (John Calder, National Oceanic and Atmospheric Administration)	TVC– will consider wording but there is no space for extra detail
15-532	A	12	15	12	15	To a non-biologist reader, the implications of "mismatch between trophic levels" needs some explanation (Philip Hill, Geological Survey of Canada)	TVC- see 15-531
15-533	A	12	18	12	19	Chapter 15.2.2.1 Terrestrial and marine ecosystems; ….predators such as	Thanks

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						mammals and birds. This sentence should be corrected to; ……predators such as marine mammals and seabirds (ref.?). A reference should be given at the end of the sentence! (Geir Wing Gabrielsen, The Norwegian Polar Institute)	
15-534	A	12	22	12	35	This pararagraph needs to be phrased in terms of vulnerability rather than just change. (Philip Hill, Geological Survey of Canada)	Accepted
15-535	A	12	22	12	24	The warming on some Antarctic Peninsula sites has been much more than 1°C in the last half of the 20th century. It has been over 2.5°C at some sites.Page 13 line 47/48. Sentence does not make sense (Lloyd Peck, British Antarctic Survey)	Noted
15-536	A	12	23			sub-antarctic islands (for consistency) (Robert Jefferies, University of Toronto)	Capitatlisation is being considered
15-537	A	12	23			Peninsula temps have warmed by ~ 2 degs since early 50's (Vaughan et al., Science, 293, p1777, 2001) (Robert Thomas, EG&G Services)	?
15-538	A	12	24	12	25	decreasing precipitation with increasing temperatures is counter to what the models predict, isn't it? Perhaps this needs to be addressed (Peter Doran, University of Illinois at Chicago)	Will check
15-539	A	12	37	12	37	"claimed" is a somewhat pejorative term that needs some explanation if it is to be left in. Who claims it and who disputes it? (Philip Hill, Geological Survey of Canada)	changed
15-540	A	12	37			"claimed" is a poor choice of words - do the authors doubt the result? (Gordon McBean, University of Western Ontario)	changed
15-541	A	12	39	12	39	indicate location of study area. Overall, the sea ice cover in the entire Antarctic region is not changing much (Josefino Comiso, NASA Goddard Space Flight Center)	Changed wording
15-542	A	12	39		40	This is a tantalizing but unclear sentence. What are the "changes" referred to? Are the predators fish? If so, are the authors referring to a depletion of fish stocks or is climate-induced? Overfishing could have the same effect if the predators are fish. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Changed wording
15-543	A	12	44	12	49	Phrasing such as "negative impacts on the local biota", "climate change is affecting the vegetation" and "further significant changes are expected" tell me nothing useful and actually gives me the feeling that information is being withheld. Perhaps the impacts, affects and significance of the changes are not all that major? Some scaling of the impacts is needed here for the reader. For example, would it be of global, regional or local significance?	Example given

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						(Philip Hill, Geological Survey of Canada)	
15-544	A	12	45			islands' no 'island' (Peter Johnson, University of Ottawa)	fixed
15-545	A	12	46			it would be appropriate in this para to recognise the associated danger of accidental transport of non-indigenous species as one of the major risks associated with increased human contact with the Antarctic (see Frenot et al., details above) (Peter Convey, British Antarctic Survey)	Changed wording
15-546	A	12	47	12	49	Is there enough soil to see anything beyond a change in mosses and lichens? That is, the changes observed at this point might be as extensive as they are likely to get - we won't have forests starting to spring up. (David E Atkinson, University of Alaska Fairbanks)	Yes, there is enough soil but forests are unlikely
15-547	A	12	47	12	49	How is climate change affecting the vegetation? (Robert Jefferies, University of Toronto)	Expalle given
15-548	A	12	49	12	49	It would be useful to clarify here what is meant by "water relations". (Claire Parkinson, NASA Goddard Space Flight Center)	reworded
15-549	A	13	1			why no information on Antarctic lakes in this section? The two Quayle refs have highlighted that some maritime Antarctic lakes can magnify the air temperature warming signal seen in this region by a factor of 2-3 x, with a wide array of rapid and significant consequences. (Peter Convey, British Antarctic Survey)	Antarctic section now included
15-550	A	13	1	13	36	This section (15.2.2.20 read like a collection of sound bites. It lacks coherent logic and doesn't really say anything of substance (Martin Sharp, University of Alberta)	Rewritten for clarity
15-551	A	13	1	13	36	There is no discussion of impacts on transportion that depend on river systems such as the Mackenzie River. The Mackenzie River is an important transportation route for the NWT. There may be positive and negative impacts related to this such as longer ice-free season and therefore longer barge season. Negative impacts could be associated with lower summer water levels. (Sharon Smith, Geological Survey of Canada)	General comment will be included in infrastructure discussion.
15-552	A	13	3	13	3	… has historically had and will continue to have … (Peter Lemke, Alfred Wegener Institute)	Wording changed.
15-553	A	13	6	13	6	throughout the text you should check the term 'thermohaline' it should be term 'thermohaline circulation' (David Barber, University of Manitoba)	Corrected as indicated.
15-554	A	13	6			stability of the thermohaline ?????? (Peter Johnson, University of Ottawa)	Corrected.
15-555	A	13	6	13	6	…. stability of the oceanic stratification and the thermohaline circulation, carbon	Corrected.

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						…. (Peter Lemke, Alfred Wegener Institute)	
15-556	A	13	7			What is meant by "vulnerabilty of the freshwater itself"? (James McCarthy, Harvard University)	Reworded.
15-557	A	13	10			suggest rewriting as "are related both to gradual transitions and to threshold transitions such as …", since both abrupt and step changes seem to me to be examples of only threshold transitions. (John Calder, National Oceanic and Atmospheric Administration)	Reworded.
15-558	A	13	13	48	48	Delete "for the future" (Marybeth Long Martello, Harvard University)	Deleted as suggested.
15-559	A	13	14	13	19	Perhaps it is the way it is written, but I don't really understand the first part of this sentence, before the parentheses. On line 18 "probably outstrip" is not very useful. Is there any data or modelling studies that demonstrate this? (Konrad Gajewski, University of Ottawa)	Reworded for clarity.
15-560	A	13	14	13	19	The English in this section needs adjusting. There probably needs to be 3 sentences. I find the text from lines 14 to 36 too condensed (too many bracketed sentences). (Robert Jefferies, University of Toronto)	Text modified for clarity.
15-561	A	13	14	40	10	Again, it is not clear why this paragraph appears in a section on adaptive capacity. The connection should be made or the paragraph moved. (Marybeth Long Martello, Harvard University)	Text modified.
15-562	A	13	15			Remove "(i.e., as ascertained…)" (Ian Joughin, Applied physics Lab, University of Washington)	Text changed.
15-563	A	13	17	13	20	Without any examples this statement looks very speculative (Vladimir Romanovsky, University of Alaska Fairbanks)	More reference to ACIA material included.
15-564	A	13	19	13	22	Again, these are broad general statements that can be neither demonstrated nor refuted. (Konrad Gajewski, University of Ottawa)	As per above response.
15-565	A	13	22	13	26	The way this is phrased comes across as an advertisement. Rephrase as "One example of an adaptation to drying wetlands is….". (Philip Hill, Geological Survey of Canada)	Rephrased for clarity.
15-566	A	13	28	13	36	Shorter winter road seasons could result (important in Canadian north) - implication for transportation of goods to communities as well as resource industries (Sharon Smith, Geological Survey of Canada)	Example of ice roads added to discussion of infrastructure.
15-567	A	13	34	13	36	This sentence selects one aspect of adaptive capacity to highlight. It seems obliquely (and somewhat negatively) aimed at First Nations communities. A broader discussion of adaptive capacity issues would be more appropriate. (Philip Hill, Geological Survey of Canada)	Edited to "…shift to more land-based and

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							near-land travel routes to avoid some increasingly hazardous ice areas)"
15-568	A	13	38			Should the heading be "Cryosphere" instead of "Permafrost since sea ice information is also presented under this heading in Fig. 15.3 and sea ice and other components of the cryosphere are as vulnerable to change, requiring adaptations (Gunter Weller, University of Alaska)	We will check the sea ice aspects of vulnerability and where they appear in the rest of the chapter
15-569	A	13	38			Sea ice and other components of the cryosphere are equally vulnerable, requiring adaptations, as permafrost (Gunter Weller, University of Alaska)	They are considered in the text of he chapter, however we do not have space for each of them to become a separate section. They are addressed in details in WG-1 report.
15-570	A	13	40	13	42	The high altitude distribution of permafrost is irrelevant to this chapter (Fiona Cawkwell, University of Alberta)	accepted
15-571	A	13	40			sub-surface (to be consistent); ditto line 45 (sub-glacial) (Robert Jefferies, University of Toronto)	Accepted
15-572	A	13	40	13	49	Rephrase the the whole section. Not sure of relevance to argument (Peter Johnson, University of Ottawa)	Text changed
15-573	A	13	40	13	42	Would all these regions be considered Polar (eg. Alps) - how is Polar defined? (Sharon Smith, Geological Survey of Canada)	Text changed
15-574	A	13	41	13	42	Delete Northern as Central has permafrost. Prefer use of term "Central Asia" instead or in addition to Tibet Plateau.Could use reference on disrtribtuion. Authors know what to use. (Jerry Brown, International Permafrsot Association)	Text changed
15-575	A	13	41	13	42	Not necessary to include non-polar regions in this list. (Philip Hill, Geological Survey of Canada)	Text changed
15-576	A	13	42	13	45	Reviw of Antarctic permafrost is inadequatel. It occupies all ice free areas. Needs a referecne. Suggest : Bockhein and Hall 2002.in South Africa Journal of Science 98: 82-90. Contributiong authors know reference. (Jerry Brown, International Permafrsot Association)	#FEN to address
15-577	A	13	42	13	42	… Tibetean Plateau …. (Peter Lemke, Alfred Wegener Institute)	Text changed
15-578	A	13	43	13	44	If most permafrost in Antarctic is in Dry Valleys, does it present the same issues as ice-rich permafrost in northern polar regions - there would not be the same consequences of thaw. (Sharon Smith, Geological Survey of Canada)	This paragraph ways nothing about the consequences, just the distribution of permafrost is discussed
15-579	A	13	44	13	45	Remove sentence on Antarctic subglacial permafrost, there is little information Arctic or Antarctic	Text changed

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						(Peter Johnson, University of Ottawa)	
15-580	A	13	47	13	49	Sentence should be in third person 'This chapter focuses on…' - the use of 'we' occurs elsewhere - in my opinion it should not be used anywhere in a scientific report of this nature (Fiona Cawkwell, University of Alberta)	Rejected
15-581	A	13				Pritchard and Vaughan is a manuscript in preparation. Morris and Mulvaney J. Glaciology 2004 pointed out an increase of accumulation that is larger than ablation increase during 1972-1998, giving a small net negative sea level contribution from the region (see IPCC WG1 cap 10 pag 52 line 14-15). (Massimo Frezzotti, ENEA)	Comment misplaced
15-582	A	14	1			ADD: Stroeve, J. et al., 2005; Meier et al 2005 line 11. Minimum is in September, not “summer”. Stroeve J. C., M. C. Serreze, F. Fetterer, T. Arbetter, W. Meier, J. Maslanik, K. Knowles. 2005. Tracking the Arctic's shrinking ice cover: Another extreme September minimum in 2004. Geophys. Res. Lett., 32, L04501, doi:10.1029/2004GL021810. Meier, W., J. Stroeve, F. Fetterer, K. Knowles. 2005. Reductions in Arctic Sea Ice Cover No Longer Limited to Summer, Eos Trans. AGU, 86(36), 326, 10.1029/2005EO360003. Arctic summer sea ice retreat (see above re- p.14) (Roger Barry, University of Colorado)	#Comment misplaced
15-583	A	14	1	14	10	As previous requested a reference to China should be included; see Global and Planetary Change 43: 19-31. (Jerry Brown, International Permafrsot Association)	#FEN to address
15-584	A	14	1			logically, the statements made in this paragraph could be challenged if we do not have available a record from the period before 50 years ago with which to show that an actual change has taken place – this is almost certainly my ignorance, but should there be explicit reference to this? (Peter Convey, British Antarctic Survey)	Actual changes are discussed in more details in WG-1, Chapter 4 report. They are limited, indeed, and this is what we wanted to note here.
15-585	A	14	1	14	10	The paragraph does not really address vulnerability. It merely states that "permafrost is being affected by global warming" (lines 6-7), which in itself is rather vague. What, where and when are the key vulnerabilities? Note also work being done by Allard et al (see comment #6), e.g. community of Salluit (Nunavik), which is already being affected by permafrost changes in very real and concrete ways, such as landslide hazard, foundation problems. (Philip Hill, Geological Survey of Canada)	These issues are discussed in, detail further in the text of the chapter, i.e. section 15.7.1.
15-586	A	14	2	14	7	Permafrost temperatures are rising as we have come out of the little ice age. Is this entire period being termed "global warming", or is that being reserved for the more recent period 1970s onward? If so it might be misleading to suggest that all	We do not consider permafrost changes in the past epochs. Here we focus on the impacts of changing permafrost. Physical processes and

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						permafrost temperature increase is due to global warming. Global warming, in terms of the recent several decades, is not regionally uniform and so we wouldn't expect permafrost response to be quite that ubiquitous. In general the definitions have to be sharp and adhered to, to avoid drift and confusion. (David E Atkinson, University of Alaska Fairbanks)	attribution of changes to specific factors is in the focus of WG-1, Chpater 4.
15-587	A	14	2	14	3	By how much did permafrost temperatures increase (Fiona Cawkwell, University of Alberta)	Such details are presented in Chapter 4, WG-1. Due to limited space we do not have them here.
15-588	A	14	3	14	7	Beilman et al. 2001 is not a very good reference with respect to information on trends in Canadian permafrost conditions as it only investigates western peatlands. A better reference which examines trends in permafrost temperature across the Canadian Arctic is Smith et al. 2005 (Smith, S.L., Burgess, M.M., Riseborough, D. and Nixon, F.M. 2005. Recent trends from Canadian permafrost thermal monitoring network sites. Permafrost and Periglacial Processes 16: 19-30). In addition, recent warming of permafrost has generally been greater and has occurred over a longer period in western Canadian Arctic. Not all observations for Europe given in Harris et al. (2003) are for polar regions and there is a need to be more specific here. Figure 15.3 does not show recent changes as is implied in the reference to it in this section (it shows projected changes instead). (Sharon Smith, Geological Survey of Canada)	Such details are presented in Chapter 4, WG-1. Due to limited space we do not have them here. All Figures will be refined.
15-589	A	14	5			Hinzman et al, 2005 (Larry Hinzman, University of Alaska Fairbanks)	Noted
15-590	A	14	5			Hinzman et al., 2004 is now published and should be referenced as Hinzman et al. 2005. The full reference is Hinzman, L.D., N.D. Bettez, W.R. Bolton, F.S. Chapin III, M.B. Dyurgerov, C.L. Fastie, D.B. Griffith, R.D.. Hollister, A. Hope, H.P. Huntington, A.M. Jensen, G.J. Jia, T. Jorgenson, D.L. Kane, D.R. Klein, A.H. Lynch, A.H. Lloyd, A.D. McGuire, F.E. Nelson, M. Nolan, W.C. Oechel, T.E. Osterkamp, C.H. Racine, V.E. Romanovsky, R.S. Stone, D.A. Stow, M. Sturm, C.E. Tweedie, G.L. Vourlitis, M.D. Walker, D.A. Walker, P.J. Webber, J. Welker, K.S. Winker, and K. Yoshikawa. 2005. Evidence and implications of recent climate change in northern Alaska and other Arctic regions. Climatic Change 72:251-298. (Anthony McGuire, University of Alaska Fairbanks)	#Noted
15-591	A	14	9			In addition to Sturm et al., 2001 and Ansimov and Belelutskaia, 2004, perhaps you should cite a new paper by Chapin et al. 2005, which can be referenced as Chapin, F. S., III, M. Sturm, M. C. Serreze, J. P. McFadden, J. R. Key, A. H. Lloyd, A. D. McGuire, T. S. Rupp, A. H. Lynch, J. P. Schimel, J. Beringer, W. L. Chapman, H. E. Epstein, E. S. Euskirchen, L. D. Hinzman, G. Jia, C.-L. Ping, K. D. Tape, C. D.	#TVC Maggan get paper: reference will be added

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						C. Thompson, D. A. Walker, and J. M. Welker. 2005. Role of land-surface changes in arctic summer warming. Science 310:657-660. (Anthony McGuire, University of Alaska Fairbanks)	
15-592	A	14	11	14	29	The use of the projected permafrost boundary is UNACCEPTABLE. Experts as well as the lay public will have no idea what constitutes a boundary change. The authors are well aware of the misrepresentaiton of this moving boundary and should explain what constitutes a boundary shift (modeled temperature change at what depth and what change in spatial continuity). (Jerry Brown, International Permafrsot Association)	All figures will be refined. Explanation of the concept of moving permafrost boundary should be given in the WG-1 Chapter 4. There is also a note that this figure was redrawn from the publication, which explains the concept of moving permafrost boundary in detail.
15-593	A	14	11			Legend of Figure 15.3, please change "Project ice extent" to "Project sea-ice extent". (Jefferson Cardia Simões, Instituto de Geociências)	Noted
15-594	A	14	11	14	38	This projection give a different impression from those used by the recent Arctic Climate Impact Assessment for sea ice projections, namely continuous vs. discontinuous sea ice late in the century. Also, presumably the projected sea ice boundaries are for Sept, but this isn't stated. (James McCarthy, Harvard University)	Figures will be refined to make sure they are adequate and are based on the most recent data.
15-595	A	14	13	14	38	Figure 15-3: Even though it is "grey" literature the final report from the Arctic Marine Transport Workshop should also be referenced for this. (David E Atkinson, University of Alaska Fairbanks)	Noted
15-596	A	14	27			archipelegos (Roger Barry, University of Colorado)	Archipeligoes is a generally-accepted alternatives spelling which I prefer since it describes the pronounciation more correctly.
15-597	A	14	29			ADD : Dyurgerov 2001, 2003 and A Glazovsky, 2004. Dyurgerov, M. B. 2001. Mountain glaciers at the end of the twentieth century: Global analysis in relation to climate and water cycle. Polar Geog., 26(4): 241-336. Dyurgerov, M.D. 2003. Mountain and subpolar glaciers show an increase in sensitivity To climate warming and intensification of the water cycle. Journal of Hydrology 282, 164-76. (Roger Barry, University of Colorado)	Comment misplaced
15-598	A	14	37	14	38	Figure 15.3 shows projected sea ice extents and permafrost boundaries. In both cases it would be good to indicate what assumptions were used in making these projections. (Claire Parkinson, NASA Goddard Space Flight Center)	# Accepted
15-599	A	14	37			Figure 15.3 This figure needs a better explanation and even a definition of the "Projected permafrost boundary". Permafrost will not completely disappear in the	There is a clear indication that the figure is redrawn from another publication, which

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						area between the "Current" and "Predicted" boundaries. Some modeling studies suggest that the permafrost in this area will start to thaw from the top down by the end of this century. However, the complete disappearance of permafrost in this area will take many centuries and even millennia (Vladimir Romanovsky, University of Alaska Fairbanks)	explains the concept of moving permafrost boundary in more details.
15-600	A	14	37	14		Figure 15.3 - What time period is the projected permafrost boundary supposed to represent. Is this the equilibrium permafrost boundary? There is a need for clarity here. (Sharon Smith, Geological Survey of Canada)	More information will be given in the figure caption. Details are given in the publication from which the figure was redrawn
15-601	A	14	37			Fig.15.3 is very intersting and important but some information on sources, e.g. models etc. used to derive ther projections for both sea ice and permafrost boundaries is needed (Gunter Weller, University of Alaska)	This is done in the original publications from which the figure is redrawn.
15-602	A	14	41	14	41	There might be more than two concerns. How about changes in ground water system, and the greening of the region? (Josefino Comiso, NASA Goddard Space Flight Center)	Here we emphasize two KEY concerns.
15-603	A	14	41			associated with the thawing of permafrost' or ' associated with thawing permafrost' (Peter Johnson, University of Ottawa)	Accepted
15-604	A	14	41	14	44	Another important concern related to thawing of permafrost is the impact on moisture fluxes. The importance of ground ice needs to mentioned when commenting on impacts on infrastructure. (Sharon Smith, Geological Survey of Canada)	Here we emphasize two KEY concerns. Importance of ground ice has been noted..
15-605	A	14	42	14	43	also access to the land for subsistence food gathering (John Streicker, Yukon College)	Here we emphasize two KEY concerns.
15-606	A	14	46	16	8	The following is a personal and relatively political statement. I question the general validity of some of the statements in this chapter (e.g. lines 35-40 and 47-49 on page 15) in relation to modern Greenlandic communities, which make up a high proportion of indigenous people in the Arctic, and which live a life more comparable e.g. to northern Norway. The modern societies of Greenland are probably very adaptable to new conditions, since they possess rich resources and analytical and advisory capabilities. Climate change will certainly pose problems to hunting communities in Greenland, but they may already be deteriorating at a faster rate than the climate is changing. My claim is that it is a 'dead end' for young people to grow up in small hunting settlements (including widespread infant neglect and even the worse), and that these people would benefit considerably from moving to the much better	This is a highly-contentious and politically-charge that is beyond the scope of the IPCC.

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						functioning towns with better education, social services and employment. The main question is how to encourage this process without too many loosers. These statements also relate somewhat to the section on pages 34-36. See even the attached national report to UN, page 122. (Hans Meltofte, National Environmental Research Institute)	
15-607	A	14	48	15	2	This text can be dropped. (David E Atkinson, University of Alaska Fairbanks)	# This text is included for completeness, and for anyone unfamiliar with the Antarctic is required to give a comprehensive picture. It can, however, be shortened
15-608	A	15	4	15	33	A lot of this section repeats what is written on page 8 lines 3 to 37 (Fiona Cawkwell, University of Alberta)	CF-CORRECT, REDUCE REDUNDANCY
15-609	A	15	4			Chapter 15.2.2.4 Populations; Same information is presented on page 8 (line 3). The indigenous people constitute 8% of the Arctic population. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	CF-TO REDUCE REDUNDANCY, ACCEPTED
15-610	A	15	4			this statement is a repeat of that on Page 8, line 3 (Robert Jefferies, University of Toronto)	CF – to reduce redundancy, accepted
15-611	A	15	4	15	33	Much of the information contained in these two paragraphs has already been given on Page 8 and elsewhere. I suggest that one of the two is reduced. (Robert Jefferies, University of Toronto)	CF-AGREED, accepted
15-612	A	15	4	16	8	Although I accept the need for an overview on what is a very complex situation for the Arctic as a whole, is it possible to provide some regional comparison in making these general statements, perhaps as a Table in order to condense information? (Robert Jefferies, University of Toronto)	CF-TO CONSIDER
15-613	A	15	4	15	12	This repeats earlier text. (Gordon McBean, University of Western Ontario)	CF-TO REVIEW AND REDUCE REDUNDANCY, ACCEPTED
15-614	A	15	6	15	7	Drop the sentence starting with "The survival…" (David E Atkinson, University of Alaska Fairbanks)	CF-accepted
15-615	A	15	8	15	9	As with an earlier similar remark, I think that this statement is easily taken out of context, i.e. the contrast of the future vs the past. The subsequent paragraphs spell this out, but I think it wise to qualify the statement in lines 8 & 9. (James McCarthy, Harvard University)	CF-accepted, to edit
15-616	A	15	11	15	13	These two sentences could be condensed into one. You could cut from "…migration" to "With" (David E Atkinson, University of Alaska Fairbanks)	CF-accepted, to edit
15-617	A	15	11	15	25	These lines repeat much of what was already said in section 15.2.1 (Philip Hill, Geological Survey of Canada)	CF-to reduce redundancy, accepted
15-618	A	15	11	15	33	An example of where reference to Arctic Human Development Report is needed	CF-already use refs from the AHRD in text.

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						(Peter Johnson, University of Ottawa)	See rest of chapter …several chapters from AHRD are referenced.
15-619	A	15	15	16	15	replace "impacts" with "consequences" (Jerry Brown, International Permafrsot Association)	CF-personal choice, rejected
15-620	A	15	15			delete 'informal' derogatory overtones (Peter Johnson, University of Ottawa)	CF-this term is used in the literature, nothing derogatory implied. Will consider to reduce word count.
15-621	A	15	15	15	22	Repeats earlier points, remove. The section in general could be trimmed a lot as it is repetitive. (Ian Joughin, Applied physics Lab, University of Washington)	CF-accepted, to edit
15-622	A	15	15	36	37	Second half of this sentence is awkward and difficult to understand. Please revise. (Marybeth Long Martello, Harvard University)	CF-accepted
15-623	A	15	15	48	48	Claim about different drivers would be stronger if text explicitly mentioned examples such as pollution, UV radiation, trade, etc. (Marybeth Long Martello, Harvard University)	CF-to consider
15-624	A	15	15	49	50	"acceptable" on line 50 is not clear. Acceptable to whom? Consider changing sentence to: "Indigenous peoples may not consider some strategies for minimizing human exposure to a hazard acceptable because these strategies can impact critical…" (Marybeth Long Martello, Harvard University)	CF-accepted
15-625	A	15	16	11	8	What about non-Indigenous Peoples? The chapter should address these populations or explain why they are not addressed? (Marybeth Long Martello, Harvard University)	CF-AGREED ! NEED TO ADD (see above)
15-626	A	15	16	11	8	This section of text repeats much of the information presented on page 8. However, here, on pages 15-6, the text is more coherent and more relevant to the section themes of vulnerability and adaptive capacity. Consider deleting or replacing the text on page 8 and retaining this text on pages 15-6. (Marybeth Long Martello, Harvard University)	CF-accepted, edits to trim
15-627	A	15	16	15	16	Hydrocarbon resource development is also an important part of the northern econonomy (Sharon Smith, Geological Survey of Canada)	CF-to consider, agreed
15-628	A	15	17			the use of 'harsh' reflects southern perceptions, Inuit would not describe as harsh and I find hot weather harsh (Peter Johnson, University of Ottawa)	CF-objective term to be used
15-629	A	15	29			there is possibly an alternative perspective to cover here which, while straying into politics, should not be ducked – while much is correctly made of the external threats to “indigenous” cultural life, it is also the case that these cultures develop, in	CF-AGREED, TO DISCUSS MODERNITY AND IMPACTS OF THESE TRENDS

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						some cases in a fashion deleterious to their environment. For instance, changes in both transport and hunting equipment (ie skidoos and guns) allow much more rapid coverage of wider areas, and greater kill frequencies, which are themselves both a threat to the fauna subject to these hunts, and a real change in the culture concerned. To be balanced, the report should include both sides – indigenous cultures cannot simply be kept in an isolated bubble, and pass all responsibility for the consequences of change on to others in the "outside", and neither should the simple use of the word "indigenous" give an automatic right to continue any particular activity. (Peter Convey, British Antarctic Survey)	
15-630	A	15	29	15	33	Does not the changing climate mean that local knowledge becomes less useful. (Gordon McBean, University of Western Ontario)	CF-NOT NECESSARILY
15-631	A	15	34			Should note on this page that life expectancies have for the most part increased in this area for both indigenous and non-indigenous populations, with the exception of Russia, whose overall life expectancy also dropped. . (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-WAS CUT…WAS THERE BEFORE
15-632	A	15	35			in middle latitudes (OR more temperate climates) (Roger Barry, University of Colorado)	CF-accepted
15-633	A	15	35			Comment on paragraph. This para seems to be focused on the adaptive capacity of indigenous populations -- what about the 90% of the poulation that is not indigenous? Moreover, even for indigenous populations, this is an overly simplistic treatment of changes in adaptive capacity. True, there probably greater reliance on fewer hunters, but their reliance on traditional foods has also declined. Moreover, being more closely tied to the global economy can enhance adaptive capacity. If there is a crash in local food sources, for example, trade allows them to import food from elsewhere, and "wage-earning employment" allows them to purchase that food (Goklany 1995). Trade allows people to diversify not only their food sources but also their diet. It allows medicines, books, computers, etc. to be obtained, all of which contribute to an increase in adaptive capacity (Goklany 2005b). Also, this para does not talk about the adoption of new technologies, e.g., snowmobiles, telephones, the Internet, satellite radios, etc., that enhance adaptive capacity. In fact, I suspect that much of the Inuit Circupolar Conference's success in pursuing the climate change issue was/is made possible by such technologies. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-AGREED
15-634	A	15	36			the point of this sentence is unclear. Does the author mean "capacity because the transition to a more sedentary lifestyle has minimized mobility"? (John Calder, National Oceanic and Atmospheric Administration)	CF-accepted, to edit

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15-635	A	15	45			"Circumpolar-wide examples illustrate…" One would expect some examples to follow this introduction, but no? (Larry Hinzman, University of Alaska Fairbanks)	CF-no room (include ref)
15-636	A	15	46	15	46	The "Populations" section here is repeating some things found in the "Climate, environment, and socio-economic state" section (lines 8-37, pg 8). Part of our charge was to look for areas where trimming could take place - this would be a good way to cull a paragraph. Other areas: p28 ln 4-5 and p25 ln 26-28 (David E Atkinson, University of Alaska Fairbanks)	CF-accepted, to edit and reduce
15-637	A	16	5	16	8	Some examples should be given for where the participatory approach "seem to be proving valuable" (James McCarthy, Harvard University)	CF-reduction of space, no space.
15-638	A	16	6			…shift of species (both plant and animal), IMPACTS ON FISHERIES, and human health effects… NOTE: Arctic fisheries are important globally. (Gunter Weller, University of Alaska)	CF-AGREED
15-639	A	16	11	16	9	I guess an editorial decision has to be made about whether or not to include these global issues in this chapter. I say this on the assumption that the impacts of the Arctic changes on the global system are developed elsewhere in WG1 or in an earlier chapter of WG2. My preference would be to not insert all these references to global impacts into different parts of this chapter because it breaks up the flow too much when the main objective is to get at impacts on the region. There could be a case for a synopsis of these points at the beginning of the chapter, butif they are properly addressed in another part of the assessmen, I don't see the need to re-iterate them here and thus dilute the impacts and adaptation message. (Philip Hill, Geological Survey of Canada)	We believe that these should be included but with reference to WGI report.
15-640	A	16	11	17	9	Recent discovery of loss of "buttressing" ice shelves triggering fast ice flow (see above) should definitely be included HERE. (Laurence C. Smith, University of California, Los Angeles (UCLA))	We agree – will be included
15-641	A	16	11			Section 15.3 needs slight re-organization. 15.3.1 starts by focusing on Arctic, but then includes Antarctica. This can be corrected by the following: (Robert Thomas, EG&G Services)	???
15-642	A	16	11	17	9	This is a read hodgepodge of items. Why not put all the feedback processes together? See also next two comments. (Gunter Weller, University of Alaska)	We believe that is clear why each of these is included here.
15-643	A	16	13	16	13	I feel it is important to have a section here for sea ice. Lumping it in with snow and ice is not adequate in my opinion. I suggest: Reductions in Sea Ice Mass Balance: Observed reductions in the minimum sea ice concentration (SIC) areal extent support modelling studies for a seasonally ice free arctic as early as 2050. The	We half agree. We will make the inclusion of sea ice more central in the bullet

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						current trend results in more than 70,000 km^2 loss of multiyear sea ice each year over the past 27 years (Barber et al. 2006). With this reduction in SIC extent there is evidence for an increase in sea ice export through Fram Strait (Kwok et al. xxxx) due to increased mobility of the central pack ice. The reduction in aerial extent also significantly decreasest the surface albedo due to the very low reflectivity of the ocean relative to that of sea ice (Perovich et al. 1998). These changes will have profound effects on Arctic-Temperate climate coupling in the decades ahead if the current trends continue. (David Barber, University of Manitoba)	
15-644	A	16	13			Why isn't North Atlantic thermohalaine circulation and deep water mass formation on this list? (James McCarthy, Harvard University)	This is well covered by WGI
15-645	A	16	13			Structure of Para 15.3.1 should have major revision. (Vladimir Pavlov, Norwegian Polar Institute)	Thanks
15-646	A	16	13			15.3.1. The list of processes feedbacks include both Arctic and Antarctic points. However, the introductory sentence says Arctic warming and its consequences may have worldwide implications……. This needs to be made into Polar warming…… or make 2 lists (one Arctic and 1 Antarctic). (Lloyd Peck, British Antarctic Survey)	Thanks
15-647	A	16	15	16	17	This section should also include reference to effects on renewable resources and on social-cultural conditions. (John Calder, National Oceanic and Atmospheric Administration)	No
15-648	A	16	15	16	17	There seems to be a disconnect between this one-sentence paragraph and the rest of section 15.3.1. I would suggest eliminating these three lines. The alternative would be to expand the paragraph to describe more fully the key regional impacts, but this would probably largely repeat material elsewhere in the chapter and would lengthen the text, which would be a problem in view of the page limitations. (Claire Parkinson, NASA Goddard Space Flight Center)	Rewritten
15-649	A	16	15	16	16	The statement "… more readily accessible mineral and fossil fuel resources" contradicts to the later statement in the same sentence "… risk to infrastructure in areas of permafrost" (Vladimir Romanovsky, University of Alaska Fairbanks)	Rewritten
15-650	A	16	15	16	17	Key impacts (as the list following suggests) should include direct physical climate links (temperature, albedo etc.) (John Streicker, Yukon College)	It is included
15-651	A	16	15			change to "…change in the Arctic and Antarctic include…." (Robert Thomas, EG&G Services)	Rewritten

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15-652	A	16	15	16	17	These are mostly (except for "shift in species") economic impacts and should be listed under a separate bullet heading right at the beginning (add the fisheries item of the next comment). Separate heading for "shift in species". (Gunter Weller, University of Alaska)	??
15-653	A	16	16			Chapter 15.3.1 Key regional impacts… What about increased land access? (Geir Wing Gabrielsen, The Norwegian Polar Institute)	
15-654	A	16	16	15	17	This introductory paragraph lists a number of human-related impacts (acess to fuels, risk to infrastructure, etc.), as key regional impacts. This paragraph appears disconnected from the bulleted list of biophysical changes below it. Add a sentence that explains that these socio-economic changes are rooted in a number of biophysical changes or otherwise make a connection. (Marybeth Long Martello, Harvard University)	Rewritten
15-655	A	16	16	7	8	Provide citations to relevant studies at the end of this paragraph. Perhaps cite Barry Smit's work, the MacKenzie Basin Impact Study (Cohen, 1997), Voices from the Bay (MacDonald et al., 1997), (Krupnik and Jolly, 2002). The Tuktu (caribou) and Nogak (calves) Project (Thorpe et al., 2001, 2002), Gary Kofinas' work with with the communities of Aklavik (2002). (Marybeth Long Martello, Harvard University)	Misplaced comment?
15-656	A	16	16	11	11	Is "Assumptions about future trends" the best title for this section? Assumptions seems like a very weak word to be using. What about simply "Future Projections" or "Estimates of Future Trends" If some of Section 15.2 is incorporated here another title could be "Current and Future Trends" (Marybeth Long Martello, Harvard University)	Title was dictated by TSU
15-657	A	16	17	15	17	This short section (15.3.1) seems a bit odd and out of place. Should it's contents be integrated into later sections? If not, the relevance of this list for the remainder of the section should be made clear. (Marybeth Long Martello, Harvard University)	Rewritten
15-658	A	16	19	17	9	The introduction (line 19, p. 16) to this list is "Arctic warming and its consequences may have worldwide implications through the following processes and feedbacks". However, some of the bullets are specifically Antarctic. Suggestion: Change "Arctic warming" on p.16, line 19 to "Polar warming". (Claire Parkinson, NASA Goddard Space Flight Center)	Rewritten
15-659	A	16	19	16	20	I am not sure that lines 19-20, p.16 are correct because it is very difficult to say how Arctic warming impacts processes in the Antarctic region, such as Southern Ocean circulation (line 48) and Southern Ocean carbon flux (p. 17 line 7). So, I suggest making change in line 19 (p.16), and instead of Arctic warming write Global warming or warming in Polar Regions.	Rewritten

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						(Vladimir Pavlov, Norwegian Polar Institute)	
15-660	A	16	20			As an individual bullet point we suggest new point: "Changes in thermohaline structure (water temperature and salinity) in the Arctic Ocean, North Atlantic and Southern Ocean". Here are some relevant references: Igor V. Polyakov, Agnieszka Beszczynska, Eddy C. Carmack, Igor A. Dmitrenko, Eberhard Fahrbach, Ivan E. Frolov, Rüdiger Gerdes, Edmond Hansen, Jürgen Holfort, Vladimir V. Ivanov, Mark A. Johnson, Michael Karcher, Frank Kauker, James Morison, Kjell A. Orvik, Ursula Schauer, Harper L. Simmons, Øystein Skagseth, Vladimir T. Sokolov, Michael Steele, Leonid A. Timokhov, David Walsh and John E. Walsh (2005). One more step toward a warmer Arctic. Geophys. Res. Lett., VOL. 32, L17605, doi:10.1029/2005GL023740). Editorial Review Essay (2005) Thermohaline circulation changes: a question of risk assessment. Climate Change 68:241-247. (Vladimir Pavlov, Norwegian Polar Institute)	These are covered well in WGI reference will be made
15-661	A	16	21	16	21	A separate entry for the perennial ice cover is very important and should be provided. It is the ice that survives at the end of the summer and is a big component of the ice-albedo feedback. A predominantly blue Arctic Ocean in summer would considerably alter the environment of the Arctic and its ecosystem (Josefino Comiso, NASA Goddard Space Flight Center)	No – this is adequately covered as it is.
15-662	A	16	21	17	9	I am not so pleased with this section. It is very uneven in quality. Some of the points are very well written with proper references while others are not. See also comments 3 and 4 above . (Elisabeth Isaksson, Norwegian Polar Institute)	Rewritten
15-663	A	16	21	16	26	As for the reflectivity of snow and ice, recent discussions by Hansen's group show the importance of soot emitted from regions far from the arctic regions. (Kiminori Itoh, Yokohama National University)	Will check out.
15-664	A	16	21	16	26	To what extent are the changes in Alaska and in Siberia linked to decadal cycles? Have there been earlier warmer phases since reliable measurements started? (Robert Jefferies, University of Toronto)	See WGI
15-665	A	16	21	16	26	This section on Reflectivity of Snow and Ice needs some citations. For disappearance of spring snow-cover in some areas, Dye (2002) should be cited and perhaps Euskirchen et al. in press, which can be referenced as Euskirchen¬¬, S.E., A.D. McGuire, D.W. Kicklighter, Q. Zhuang, J.S. Clein, R.J. Dargaville, D.G. Dye, J.S. Kimball, K.C. McDonald, J.M. Melillo, V.E. Romanovsky, and N.V. Smith. 2006. Importance of recent shifts in soil thermal dynamics on growing season length, productivity, and carbon sequestration in terrestrial high-latitude ecosystems. Global Change Biology. In press. The new paper by Chapin et al. 2005 (see previous comment) could be cited at the very end of the section.	Info for Maggan – NO action for TVC

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						(Anthony McGuire, University of Alaska Fairbanks)	
15-666	A	16	21			Bullet point 1 should be divided into two parts. First-"Precipitation and Snow Cover", and second-"Glaciers and Sea Ice". The reason is that the major consequences of Arctic warming may have worldwide implications through decrease of sea ice extent and wastage of glaciers. (Vladimir Pavlov, Norwegian Polar Institute)	We believe that this is well covered in the revised version
15-667	A	16	23	16	26	It seems appropriate to mention here as well the arctic summer ice shrinkage (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Rewritten
15-668	A	16	24	16	24	references should be provided for rapid disappearance of spring snow cover (Josefino Comiso, NASA Goddard Space Flight Center)	Rewritten
15-669	A	16	24	16	25	It would be appropriate to mention here the reduction of sea ice, in addition to the more rapid disappearance of spring snow. This could be done simply by adding "and a reduction of sea ice" before the second comma on line 25. (Claire Parkinson, NASA Goddard Space Flight Center)	Rewritten
15-670	A	16	25			Redraft this phrase to avoid use fo forcing twice - it is confusing. (Gordon McBean, University of Western Ontario)	Rewritten
15-671	A	16	25			"forcing on albedo may lead to further forcing…" Why do we say "may"? Radiative forcing and albedo are clearly understood and directly measurable. We need to be definitive when the science and/or TK are clear. E.g. "...albedo leads to further forcing…" (John Streicker, Yukon College)	Rewritten
15-672	A	16	27	16	33	There are recent results, reported by Hansen and at Exeter conference on more rapid and possibly irreversible melting of Greenland ice sheet and resulting sea level rise. (Gordon McBean, University of Western Ontario)	Rewritten
15-673	A	16	27			The bullet point "Ocean Circulation" should include changes of circulation in the Arctic Ocean, North Atlantic and from the point Southern Ocean circulation (line 48). In this case this point (Southern Ocean circulation) should be removed. (Vladimir Pavlov, Norwegian Polar Institute)	
15-674	A	16	27			In bullet point "Sea Level" should mention that not only retreat of mountain glaciers in the Arctic is contributing to the increase in global sea level but also such factors as steric effect connected with warming and freshening of the arctic waters, inverted barometer effect connected with decreasing of sea level pressure, and reorganization of thermohaline water circulation will all contribute significantly in sea level rise. The relevant references are: Proshutinsky, A., V. Pavlov and R. H. Bourke (2001) Sea level rise in the Arctic Ocean. Geophys. Res. Lett., 28, 11,	The word "contributing" reminds the reader that there are other sources.

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						2237-2240). Levermann, A., Griesel, A., Hofmann, M., Montoya, M. and Rahmstorf, S. (2005) Dynamic sea level changes following changes in the thermohaline circulation. Climate Dynamics 24:347-354, doi:10.1007/s00382-004-0505-y (Vladimir Pavlov, Norwegian Polar Institute)	
15-675	A	16	27			I suggest also to divide into three individual bullet points: “Freshwater Runoff”, “Sea Level” and “Ocean Circulation”. (Vladimir Pavlov, Norwegian Polar Institute)	No room is available for such a distinction
15-676	A	16	27	16	33	I was surprised to see no mention of changes in ice flow dynamics and iceberg calving rates as sources of freshwater to the ocean. Some people at least think this is an important issue for Greenland and there is a lot of evidence of accelerated ice flow in some of the major drainage basins in Antarctica. (Martin Sharp, University of Alberta)	Now included
15-677	A	16	27	16	30	This sentence is weak. Losses from Greenland are substantial, and they are caused by both melting and by accelerated glacier discharge. These changes are documented in several papers starting in the late 1990s. There is also the strong possibility that warming during the 21st century will take the Greenland ice sheet to "the point of no return". (Robert Thomas, EG&G Services)	Now included
15-678	A	16	27			Same comment as above re sea levels. This new study should be mentioned. (Peter Wadhams, University of Cambridge)	??
15-679	A	16	29			Refer to the Abdalati et al., 2004 paper here on Canadian Ice Cap mass balance. Also there is no mention of an important paper by Paterson and Reeh (2001) on the elevation changes in Greenland over 40 years. (David Fisher, Geological Survey of Canada)	Will check out
15-680	A	16	29	16	29	The observations by Abdalati and Steffen (2001) indicate an increase of the melt area. But there is no statement of "more rapid melting" to be based on this publication. A better reference is Alley et al, Science 310,456-460 (2005), which states an increased net loss of the Greenland ice sheet: 0.15mm/year sea level rise for 1993-1999 and 0.21mm/year for 1997-2003. (Peter Lemke, Alfred Wegener Institute)	Will check out
15-681	A	16	30			16-30: The issue with Greenland is not just melt but also dynamic thinning. You might add “and dynamic thinning (caused by accelerated flux through the narrow outlet glaciers) (e.g., Thomas et al., 2003)” after the Abdilati and Steffen ref. Thomas, R. H., W. Abdalati, E. Frederick, W. B. Krabill, S. Manizade, and K. Steffen (2003), Investigation of surface melting and dynamic thinning on Jakobshavn Isbrae, Greenland, J. Glaciol., 49, 231-23	Accepted

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						(Ian Joughin, Applied physics Lab, University of Washington)	
15-682	A	16	33			A bullet should be added summarizing the large changes in Antarctica: ice-shelf thinning and breakup; massive acceleration and thinning of their tributary glaciers. (Robert Thomas, EG&G Services)	Will include
15-683	A	16	34	16	37	This paragraph on Arctic carbon flux should be rewritten for improved clarity (Josefino Comiso, NASA Goddard Space Flight Center)	Accepted – text modified
15-684	A	16	34	16	37	"are likely to be altered" what does this mean? (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-685	A	16	34			I suggest merging bullet points “Arctic carbon flux” and “Southern Ocean carbon flux” into one: “Carbon flux in the Arctic and Antarctic”. (Vladimir Pavlov, Norwegian Polar Institute)	NO: the two themes are too different and should not be merged
15-686	A	16	35	16	35	add after soils "and permafrost" (Jerry Brown, International Permafrsot Association)	Not now relevant
15-687	A	16	35	16	36	The following recent reference should be given somewhere in the text, related to methane release, since remote satellite sensing provides measurement methods previously unavailable. Frankenberg, C., J.F. Meirink, M. van Weele, U. Platt, and T. Wagner: Assessing Methane Emissions from Global Space-Borne Observations. Sciencexpress/ www.sciencexpress.org/ 17 March 2005/ pp1-4/ 10.1126/science.1106644 (David Malcolm, Arctic Energy Alliance)	No action: this reference is not particularly relevant to high latitudes
15-688	A	16	36			can the author provide more insight into the word "altered"? (John Calder, National Oceanic and Atmospheric Administration)	Not now relevant as text has been changed
15-689	A	16	36			change "carbon dioxide" to "greenhouse gases" or 'radiatively active gases" (Larry Hinzman, University of Alaska Fairbanks)	Not now relevant as text has been changed
15-690	A	16	36			Actually, "and carbon dioxide concentration change" is a bit misplaced here altogether. In essence, it says that veg will change when carbon dioxide changes… in theory that is true, but CO2 fertilization is really weak compared to the indirect effects of temp increase caused by increases in CO2 concentrations. (Larry Hinzman, University of Alaska Fairbanks)	Not now relevant as text has been changed
15-691	A	16	37	16	37	The role of sea ice in carbon fluxes between the ocean and atmosphere are poorly understood. Recent results indicate that sea ice is not an impermiable layer to gas exchange as previously though (Papakyriakou and Miller, 2006) and that changes to primary and secondary production could change the relative role of the Arctic ocean as a source or sink for atmospheric CO2. (David Barber, University of Manitoba)	Will consider
15-692	A	16	37			In addition to Anisimov et al. 2005a, you should cite Sitch et al. in press, which can be referenced as Sitch, S., A.D. McGuire, J. Kimball, N. Gedney, J. Gamon, R.	Now occurs in a later section where it is more appropriate

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						Engstrom, A. Wolf, Q. Zhuang, and J.S. Clein. 2006. Assessing the circumpolar carbon balance of arctic tundra with remote sensing and process-based modeling approaches. Ecological Applications. In Press. You might also cite Zhuang et al. in press with respect to the biogenic methane issue, which can be referenced as Zhuang, Q., J. M. Melillo, A. D. McGuire, D. W. Kicklighter, R. G. Prinn, P. A. Steudler, B. S. Felzer, and S. Hu. 2006. Net land-atmosphere exchanges of CH4 and CO2 in Alaska: Implications for the region's greenhouse gas budget. Ecological Applications. In press. (Anthony McGuire, University of Alaska Fairbanks)	
15-693	A	16	38	16	42	this paragraph is very vague- please rewrite (Elisabeth Isaksson, Norwegian Polar Institute)	Accepted – text modified
15-694	A	16	43	16	43	add after "in and beneath"; this section could use a reference; several by N.A. Romanovskii and H-W. Hubberten (Jerry Brown, International Permafrsot Association)	
15-695	A	16	43	16	44	Changes in methane hydrates on Arctic continental shelves is mentioned here in terms of methane release. Is there also an issue concerning potential slope instablility on the continental slope? It is known that huge slope failures, on the Norwegian margin for example, have led to tsunami in the past. The most recent major event was the Storegga Slide at 7-8,000 years ago and geological records of major innundation around, for example, the Faeroes, Sheltland, NE Scotland and some Norwegian fjords. Might the probability of such submarine failures be increased by changes in submarine methane hydrates? (Julian Dowdeswell, University of Cambridge)	We are not sure that this is a well enough understood issue to be highlighting at this time
15-696	A	16	43	16	47	Should mention references such as the following two: E. Dendy Sloan Jr.: Fundamental principles and applications of natural gas hydrates. Nature, Vol 426, 20 November 2003, pp 353-359 AND I.A. Pecher: Gas hydrates on the brink. Nature, Vol 420, 12 December 2002, pp 622-623 (David Malcolm, Arctic Energy Alliance)	Possibly, if space permits
15-697	A	16	43	16	44	What is the time scale of the possible decomposition of methane hydrates and the consequent release of methane into the atmosphere? (Vladimir Romanovsky, University of Alaska Fairbanks)	?
15-698	A	16	43	16	47	Methane hydrates are within and beneath permafrost. It is important to indicate that methane hydrates may be found in sedimentary basins rather than implying that they can be found throughout the arctic. In terrestrial areas, hydrate is generally only found below depths of 200 m and warming over a long period will be required for its decomposition and release to the atmosphere. It is important to put the potential impact of warming on gas hydrates in perspective and comment on its	?

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						relative importance to other impacts. Some recent references need to be presented here that discuss the climate change impacts related to gas hydrates. While methane may be a more efficient greenhouse gas, it is important to note that it does oxidize to CO2 in the atmosphere. (Sharon Smith, Geological Survey of Canada)	
15-699	A	16	46	16	47	does methane not have much shorter residence in atmosphere and therefore cumulative effect is different (Peter Johnson, University of Ottawa)	?
15-700	A	16	47	16	47	"influence that carbon dioxide". Incomplete sentence. Add 'has' to the end. (Bruce Forbes, University of Lapland)	Rewritten
15-701	A	16	47			than' not 'that' (Peter Johnson, University of Ottawa)	Rewritten
15-702	A	16	47			Suggest changing this line to read "influence of carbon dioxide on a 100 year time scale.". (Anthony McGuire, University of Alaska Fairbanks)	Rewritten
15-703	A	16	48	17	6	Ocean temperature directly seaward of Antarctic's continental shelf break have risen by ~0.2°C over recent decades, which is sufficient to increase basal melting by ~2m/yr where that change has reach vulnerable grounding line (Rignot & Jacobs, Science, 2002). Ocean measurements in the Ross Sea over the past four decades reveal marked freshening (decrease in shelf water salinity and surface salinity) during the late 20th century. The freshening appears to have resulted from a combination of factors, including increased precipitation, reduce sea ice production, and increased melting of the West Antarctic Ice Sheet (Jacobs et al., Science, 2002). On my opinion this are important issue to report in key regional impact. (Massimo Frezzotti, ENEA)	Much of this is covered by WGI
15-704	A	16	48	17	6	This sentence need to be removed because the work behind this sentence is out of date and doesn't reflect state of art understanding of the THC (see WG1 chapter 11) (Jari Haapala, Finnish Institute of Marine Research)	Accepted - Rewritten
15-705	A	16	48	17	6	frehwater influx in th Arctic is also being considered vis a vis the thermohaline. It would be appropriate to link this bullet to the Arctic or the second bullet (line 27) to the thermohalnie and the AABW. (John Streicker, Yukon College)	Rewritten
15-706	A	16	49	16	49	insert after "ice" to read "ice in coastal regions…" Brine needs to accumulate in the shelf regions before they can have the density and salinity of AABW. (Josefino Comiso, NASA Goddard Space Flight Center)	Rewritten
15-707	A	16	50	17	2	The shutdown of the thermohaline circulation seems less likely in view of more	Will make more reference to WGI

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						recent work. Recommend looking at Richard Kerr's news article in Science, "Confronting the Bogeyman of the Climate System" in Science, 21 October 2005, pp. 432-433. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
15-708	A	17	0	25		General comment - there is way too much use of 'in prep' literature by the authors in these sections. Link out to well established literature rather than citing work that is still in preparation. (David Barber, University of Manitoba)	Agreed – all in preps will be dropped if not in press and logded with TSU
15-709	A	17	1	17	2	Specify how AABW production is related to the shutdown through 3-fold increase in greenhouse gases (Josefino Comiso, NASA Goddard Space Flight Center)	Rewritten
15-710	A	17	2			Contrast statement p. 16 line 53-4 that PF melt is not involved. Suggest reverse order of these two sentences (Roger Barry, University of Colorado)	??? Misplaced comment
15-711	A	17	2	17	6	this sentence does not provide any clear and relevant information and should be discarded. (Elisabeth Isaksson, Norwegian Polar Institute)	
15-712	A	17	7	17	8	Check these sentences. (David E Atkinson, University of Alaska Fairbanks)	Rewritten
15-713	A	17	7	17	8	incomplete sentence (John Calder, National Oceanic and Atmospheric Administration)	Rewritten
15-714	A	17	7	17	8	Incomplete sentence (Peter Johnson, University of Ottawa)	Rewritten
15-715	A	17	7			Change “that stratification” to “a stratification” (or complete the sentence). (Ian Joughin, Applied physics Lab, University of Washington)	Rewritten
15-716	A	17	7	17	7	….. indicate a stratification …. (Peter Lemke, Alfred Wegener Institute)	Rewritten
15-717	A	17	7	17	8	Incomplete sentence. (Hans Meltofte, National Environmental Research Institute)	Rewritten
15-718	A	17	7	17	8	It's important to complete this sentence and indicate what it is that climate models indicate about the stratification of the Southern Ocean. (Claire Parkinson, NASA Goddard Space Flight Center)	Rewritten
15-719	A	17	7			Sentence makes no sense. (Lloyd Peck, British Antarctic Survey)	Rewritten
15-720	A	17	7	17	8	Looks like some part of this sentence is missing (Vladimir Romanovsky, University of Alaska Fairbanks)	Rewritten
15-721	A	17	8	17	9	Incomplete sentence	Rewritten

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						(Manfred Lange, University of Muenster)	
15-722	A	17	10			remains unclear but is… (Roger Barry, University of Colorado)	JW: Changed as suggested
15-723	A	17	12	18	32	There are subsections here on "Projected atmospheric changes", "Projected changes in the oceans", and "projected changes in cryosphere". Prominently missing is a section on "Projected changes on the land". This could be fixed either by adding a land section or by replacing the cryosphere section by a land section and including sea ice in the ocean section and land ice and snow in the land section. (Claire Parkinson, NASA Goddard Space Flight Center)	JW: Changed according to second suggestion
15-724	A	17	12			this section on projected atmospheric changes do not discuss storminess.or winds. These are essential variables for assessment of coastal impacts. (Steven Solomon, Geological Survey of Canada)	JW: Climate models have not been shown to capture credibly the wind regimes in polar/subpolar coastal regions for the present climate – let alone the future climate. Accordingly, in view of our length constraints, there is little basis for an additional section on projected changes in storms and winds.
15-725	A	17	14	17	14	Be more specific about the time period of change. For example, change "By the end of" to "During the" (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Changed as suggested
15-726	A	17	14	19	43	Some reduction may be possible in this section as most of the evidence appears to come from Chapter 11?? (Robert Jefferies, University of Toronto)	JW: Approximately half of these 2.5 pages have been deleted.
15-727	A	17	14	17	16	It may be worthwhile to comment on some of the difficulties with projections of climate in the Arctic. For example the coarse resolution of most GCMs means that the Canadian High Arctic (Arctic Archepelego) is not represented very well due to the distribution of land and water. A comment on the spatial variability in warming would also be useful - greater warming at higher latitudes. (Sharon Smith, Geological Survey of Canada)	JW: These are valid comments, but they are more appropriate to Chapter 10 of WG I. We have added a caveat that regions like the Canadian Archipelago are not well resolved.
15-728	A	17	15	17	16	I would suggest changing "ranges" to "is projected to range" so it is clear it is a projection rather than a fact. And it might be helpful to explain what is meant by "ensemble member"--these typically show short-term variations and what I would think should be used here are the time-averaged results, so does "ensemble member really matter much? (Michael MacCracken, Climate Institute)	JW: Changes made as suggested. (We eliminated the mention of ensemble member).
15-729	A	17	16			Isn't there a mismatch between the statement on page 7, line 12, that the past warming has been strongest during spring and winter, and the coming to be strongest in autumn and winter?	JW: Yes, there is what can be called a mismatch. We are indeed pointing out that the seasonalities of the observed and projected

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Hans Meltofte, National Environmental Research Institute)	changes are different.
15-730	A	17	22			These results are in ACIA report. (Gordon McBean, University of Western Ontario)	JW: The 10 lines including and surrounding this line have been deleted to meet our length constraints.
15-731	A	17	24	17	28	No where is entertained the possiblity that polar amplification, as a concept, may be incorrect. Such a comment could go in this paragraph. I refer most specifically to comments by Polyakov et al. 2002, which was already cited as an example of multi-decadal trends in air temperature in the arctic. In fact that point is made in suport of their broader hypothesis, that questions the strength and manifestation of polar amplification. (David E Atkinson, University of Alaska Fairbanks)	JW: We have deleted the paragraph in which polar amplification is mentioned.
15-732	A	17	24	17	28	The idea of using inter-model differences as a measure of natural variability is just plain silly, especially when other (paleo) measures are available. Or have I misunderstood what is being said here. (David Fisher, Geological Survey of Canada)	JW: We have deleted the offending sentences, specifically the old p. 17, lines 18-28.
15-733	A	17	24		28	Rewrite -- I'm not sure what this says…. Does this mean the projected arctic warming or the projected arctic variability is no greater than global? Either way, a very convoluted sentence. (Larry Hinzman, University of Alaska Fairbanks)	JW: We have deleted the confusing sentences, specifically the old p. 17, lines 18-29.
15-734	A	17	26			Why is the intermodel variance a proxy - why not use observations or long integrations or both. (Gordon McBean, University of Western Ontario)	JW: We have deleted the confusing sentences, specifically the old p. 17, lines 18-29.
15-735	A	17	27			...Arctic than that in... (Robert Jefferies, University of Toronto)	JW: This entire paragraph has been deleted.
15-736	A	17	30	17	32	There is no reference given here for the statement that "there is wider disagreement among models concerning polar amplification in the Antarctic." A very appropriate reference would be Parkinson, C. L., 2004: Southern Ocean sea ice and its wider linkages: insights revealed from models and observations." Antarctic Science, 16 (4), 387-400. In this paper there's a section entitled "Evolving expectations regarding polar amplification of climate change", where a short history is given of polar amplification (or lack thereof) in different model simulations. The final paragraph of the section in this 2004 reference begins: "Thus, although expectations of a polar amplification of climate change had been simulated in both hemispheres with several models in the 1980s and early 1990s, as models grew more sophisticated in their treatment of the oceans and incorporated sea ice dynamics, the simulated strong polar amplification tended to remain in the Northern Hemisphere but not in the Southern Hemisphere. This tendency toward reduced south polar	JW: Reference has been added.

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						amplification, however, reversed somewhat when ..." (Claire Parkinson, NASA Goddard Space Flight Center)	
15-737	A	17	31			..there is wide disagreement... OR there is disagreement... (Robert Jefferies, University of Toronto)	JW: Changed as suggested in following reviewer comment.
15-738	A	17	31	7	31	I would suggest replacing "is wider disagreement among models" by "are differences among the model projections"--I don't quite understand what "wider disagreement is compared to unanimity, where there is no disagreement. (Michael MacCracken, Climate Institute)	JW: Changed as suggested.
15-739	A	17	32	17	32	I would suggest changing "models' simulations, however" simply to "model simulations" (Michael MacCracken, Climate Institute)	JW: Changed as suggested.
15-740	A	17	33	17	33	describe exact location of this narrow Sourthern Ocean band. Note that the Antarctic sea ice has not been retreating in the last 26 years. (Josefino Comiso, NASA Goddard Space Flight Center)	JW: The location of the band varies from model to model, depending on where each model simulates the present-day ice edge. We believe that this will be apparent to most readers.
15-741	A	17	36	17	37	Precip for what area? (David E Atkinson, University of Alaska Fairbanks)	JW: Have added “in the Arctic”.
15-742	A	17	36	17	36	The partitioning of precipitation into snow and rain is also important - can some comments be made here? (Sharon Smith, Geological Survey of Canada)	JW: Sentence making this point has been added.
15-743	A	17	36	17	46	The big story with precipitation is not the trend, but rather the variability (spatially, temporally and in amplitude). For example, a low net increase in precipitation still misses that the snow load we need to design structures for appears to be increasing. (John Streicker, Yukon College)	JW: A more important factor for snow loads is likely to be the changes of the proportion of rain and snow. See preceding reviewer comment and our response. We have added a mention of the effect on on snow loads.
15-744	A	17	44	17	44	Change "by the late 21st century" to "over the course of the 21st century" (Michael MacCracken, Climate Institute)	JW: Changed as suggested.
15-745	A	17	50	17	51	Note that habitat for ice algae will likely decrease. (Roger Barry, University of Colorado)	JW: This comment does not match the cited page/line numbers. It seems appropriate for Section 15.4.3.
15-746	A	18	4	18	5	Is Chapter 11 still the source of this information? References are needed. (Robert Jefferies, University of Toronto)	JW: This paragraph has been deleted.
15-747	A	18	8	18	8	Discussions of the projected changes in the ocean should include the changing hydrography and productivity as impacted by changes in the characteristics of the sea ice cover. It is the sea ice that ventilates the ocean, that insulates it from the atmosphere, that reflects solar radiation, and that enables phytoplankton to grow	JW: These topics are covered in Sections 15.4.1.2 (Impacts on physical regime – see hydrologic discussions) and in Sections 14.4.3 and 15.4.5 (Marine ecosystems and their

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						rapidly. The section should be completely rewritten. (Josefino Comiso, NASA Goddard Space Flight Center)	services).
15-748	A	18	8			15.3.3: Sea ice and glacier melt rates in the Arctic were much higher in the early Holocene (11 ka BP to 8 ka BP) than now, but only at 8.2 ka was there a suspicion of a shutdown of the thermohaline "pump" caused by fresh water capping. And the 8.2 ka example has been attributed to the breakout of Laurentide meltwater storage. While the melting of the multi year sea ice and increase in river input to the Arctic Ocean is having some effects (as yet not fully understood), it is not at all clear whether any thermohaline shut downs are possible from these inputs. So I would soft peddle such implications. (David Fisher, Geological Survey of Canada)	JW: In the old Section 15.3.3, we have deleted the middle paragraph that referred to a stabilization of the water column in association with changes in P-E, river discharge and sea ice melt.
15-749	A	18	8		30	The link between the two sentences is not clear here. I think you should at least use "iceberg calving". (Tavi Murray, University of Wales Swansea)	JW: We have changed "calving" to "iceberg calving" as suggested. Note that the middle paragraph of Section 15.3.3 has been deleted, thereby tightening the text.
15-750	A	18	8			the section on projected changes in the oceans does not discuss sea level rise! (Steven Solomon, Geological Survey of Canada)	JW: The topic of sea level rise is covered by Working Group I, so including any details here would be redundant. We have added statements referring the reader to WG I's Section 10.6 for this topic.
15-751	A	18	10	18	29	This section seems a bit thin - could there be more about potential sea level rise, ocean circulation, thermhaline circulation changes etc in order to merit the subsequent discussions about marine ecosystems etc which are acknowledged in line 22 to be tentative (Fiona Cawkwell, University of Alberta)	JW: Both these topics are more appropriate to WG I. As stated in the previous response, we have added statements referring the reader to WG I's Section 10.6 for projections of sea level change. Review comment 15-748 asked us to downplay the connection to the thermohaline circulation.
15-752	A	18	11	18	11	Johannessen, O.M. et al. has just published a paper "Recent ice-sheet growth in the interior of Greenland" (Science express, 20 October 2005, see: http://www.sciencemag.org/sciencexpress/recent.shtml). This paper points out that the ice sheet is actually growing and contradicting the reports of Greenland ice sheet melting. I would suggest that you have a look at this paper or discuss the matter with the authors. (Arne Instanes, OPTICONSULT Consulting Engineers)	JW: In Section 15.2.1, we have added the reference to Johannessen et al (2005) and have summarized their conclusion about the Greenland mass balance.
15-753	A	18	13			Change "calving rates" to "ice discharge" rates (its ice discharge across the grounding line that is important to sea level). (Ian Joughin, Applied physics Lab, University of Washington)	JW: "Ice discharge" is now used in this paragraph.

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15-754	A	18	14	18	29	No reference to changes in Canadian Ice caps (Abdalati et al., 2004) and no reference to the much longer time base line study of Paterson and Reeh (2001). These are important papers and should be reference (David Fisher, Geological Survey of Canada)	JW: These are in the domain of Working Group I – see Chapter 4, Section 4.5 of WG I.
15-755	A	18	20			remove 'a' (Peter Johnson, University of Ottawa)	JW: This entire paragraph has been deleted.
15-756	A	18	20			Delete “a” (Lloyd Peck, British Antarctic Survey)	JW: This entire paragraph has been deleted.
15-757	A	18	22	18	22	Change "but based on the" to "although likely to involve" (Michael MacCracken, Climate Institute)	JW: This entire paragraph has been deleted.
15-758	A	18	24	18	24	The sea ice extent shows a decrease by 7% per decade. The sea ice area (without the leads between the ice floes) shows a decrease of 9%. (Peter Lemke, Alfred Wegener Institute)	JW: This comment apparently refers to Section 15.2.1, para. 2, where recent decreases of sea ice extent were summarized. We have deleted that entire paragraph because of overlap with WG I, Chapter 4.
15-759	A	18	25	18	25	Change to "The projections of Southern Ocean hydrography" (Michael MacCracken, Climate Institute)	JW: We have altered this sentence by removing “currents”, and also by making it bi-polar in response to other reviewer comments. The fact that the hydrographic variables differ among models in present-day simulations as well as projections is a point we consider important to the paragraph.
15-760	A	18	26	18	29	This would be a more useful sentence if the importance of this difference were somehow indicated. Does this matter at all to people? Does it affect the climate, etc.? (Michael MacCracken, Climate Institute)	JW: The variations amond simulated ACC transports may not matter directly to people, but they illustrate the point that the models’ simulations of the Southern Ocean have large uncertainties, thereby limiting conficdence in projections. So we have retained the sentence.
15-761	A	18	32			section 15.3.4: There is no mention of an important report-workshop on Arctic climate change, sea ice and glacier change (the Ross Brown and CRYSYS report on 1998 summer). This report and the meetings that went with it should be used and referenced. (David Fisher, Geological Survey of Canada)	JW: This workshop report is in the grey literature, and we have been urged by the TSU to minimize references to the grey literature.
15-762	A	18	34	18	35	Freshwater ice cover (lake and river ice) should also be included in the definition of the cryosphere and should be included in the discussion. (Sharon Smith, Geological Survey of Canada)	JW: The cryospheric sentence on the old p. 18, lines 34-35 has been deleted due to a restructuring of Sections 15.3.3 and 15.3.4, in response to reviewer comment 15-723. We

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							have added a statement about future changes of river and lake ice in the first paragraph of Section 15.3.4.1.
15-763	A	18	39	18	44	Some reduction may be possible here as some of the statements are a repeat of earlier statements. (Robert Jefferies, University of Toronto)	JW: We have deleted the first 9 lines of the old Section 15.3.4.1. That material is covered by Working Group I in their Chapter 4.
15-764	A	18	39		44	The latest discoveries that 2004 and 2005 had the lowest sea ice cover on record should be updated here. (Laurence C. Smith, University of California, Los Angeles (UCLA))	JW: See preceding response. Workinng Group I shows the sea ice variations through October 2004 in their Figs. 4.4.1 and 4.4.2.
15-765	A	18	41	18	41	The Cavalieri, Parkinson, Vinnikov 2004 reference here is a non-refereed note in the Bulletin of the American Meteorological Society. It would be more appropriate instead to reference the more complete, refereed article Cavalieri et al. 2003 by the same authors (and already included in the reference list). Also, a reasonable additional reference to insert here, along with the Cavalieri et al. 2003 reference, would be: Meier, W., J. Stroeve, F. Fetterer, and K. Knowles, 2005: Reductions in Arctic sea ice cover no longer limited to summer, Eos, 86 (36), 326. (Claire Parkinson, NASA Goddard Space Flight Center)	JW: See preceding two responses. This material is covered appropriately by Working Group I in their Chapter 4.
15-766	A	18	43	18	43	Insert before the sentence starting with "Evidence." Subsequent data show accelerated decline with the minimum ice cover in 2005 being observed to be the least extensive during the satellite era and is 19% lower that the average of ice extent minima from 1979 to 2004. (Josefino Comiso, NASA Goddard Space Flight Center)	JW: As noted in preceding three responses, the cited lines have been deleted. The recent sea ice retreat is documented by Working Group I, Chapter 4.
15-767	A	18	43	18	43	"indiate thinning of ice" is vague. Has this been quantified in this paper? How reliable are these data? (Elisabeth Isaksson, Norwegian Polar Institute)	JW: This statement has been deleted; see preceding four responses.
15-768	A	18	44			in addition to Wadams and Davis (2000) add the Rothrock et al (1999) reference. (Josefino Comiso, NASA Goddard Space Flight Center)	JW: As noted in the preceding five responses, this statement has been deleted because the topic is covered by WG I in their Chapter 4.
15-769	A	18	45			A recent synthesis of modeling results with physical analyses caused one group to conclude loss of summer sea ice was inevitable under the current climatic regime. (See Overpeck, J. T. M. Sturm, J. A. Francis, D. K. Perovich, M. C. Serreze, R. Benner, E. C. Carmack, F. S. Chapin III, S. C. Gerlach, L. C. Hamilton, L. D. Hinzman, M. Holland, H. P. Huntington, J. R. Key, A. H. Lloyd, G. M. MacDonald, J. McFadden, D. Noone, T. D. Prowse, P. Schlosser, and C. Vörösmarty. 2005. Arctic System on Trajectory to New, Seasonally Ice-Free State. 86(34): 309, 312–313. 23 August 2005.) (Larry Hinzman, University of Alaska Fairbanks)	JW: Lines 47-49 of the FOD's p. 18 summarize the sea ice retreat projected by the model simulations performed for AR4. This information provides a range of percentage losses of sea ice by a specific timeslice (2080-2100) under various greenhouse forcing scenarios. We consider this summary to be a more robust assessment than a statement that "loss of summer sea ice is inevitable",

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							especially since it is based on model simulations performed for AR4, and it is consistent with Figure 10.3.10 of WG I..
15-770	A	18	45	18	45	How can a model that shows "essentially no change" be viewed as at all credible given current trends--has this model been tested in any reasonable way? Does its base case have so much or so little summer ice that the changes are not being seen in the results, etc.? But this result seems so absurd, I would think it should be thrown out--or at least it needs explanation. [Note, during the ACIA look at the model results, a number of models showed that in some coastal regions the number of days above 0 C in the summer went down--when we looked closely at this, what had happened was that the ice had melted and the coastal temperatures were now closer to the temperature of the open sea water at -1 C or something. I wonder if the test of whether there is or is not sea ice is thus fouled up in the analysis of the model showing no change.] (Michael MacCracken, Climate Institute)	JW: The statement referred to here is consistent with WH I's Figure 10.3.10. We do believe that it is our role to selectively throw out some models because their scenario results are counterintuitive. The unexpected is always a possibility – a shutdown of the THC or a substantial change of the polar cloud regime could lead to some surprising changes (or non-changes) of sea ice..
15-771	A	18	48			The projected sea ice extent in Fig. 15.3 is from 2070 to 2090, whereas this sentence refers to 2080 to 2100 (Robert Jefferies, University of Toronto)	JW: Fig. 15.3 is based on the ACIA, while the numbers presented from p. 48, line 48 are from a more recent study based ona recently published paper summarizing changes of sea ice in simulations made for IPCC AR4. We cannot change the dates in these two different published studies. Moreover, the two sets of results are so similar that the slight difference of time period is inconsequential.
15-772	A	19	0			the section on projected changes in the cryoshpere does not address the issues of regional variations in sea ice extent - especially in the coastal areas where erosion and flodding impacts will occur. Note that there are regional differences in the retreat of sea ice that result in different degree of impact on local communities. Also - changes in coastal and landfast sea ice changes are inadequately evaluated and addressed. (Steven Solomon, Geological Survey of Canada)	JW: There are no published results to cite on the projected regional changes of sea ice. Projections of sea ice change are appropriately included in Chapter 10 (Section 10.3.3) of WG I. In that section the most specific statement on spatial patterns of projected sea ice changes is "Arctic sea ice thins fastest where it is initially thickest".
15-773	A	19	4			Another point to note is the uncertain impact that changes in sea ice concentration will have on land ice, e.g. through changing the microclimate with moisture bearing winds etc, and also dynamically with reduced sea ice promoting increasing glacier calving and potentially higher flow rates with the removal of a sea ice barrier (Fiona Cawkwell, University of Alberta)	JW: We have added these points to the first paragraph of the new Section 15.3.3.

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15-774	A	19	6	19	12	Comments on links between changes in snow cover and permafrost conditions could be given. (Sharon Smith, Geological Survey of Canada)	JW: The linkage between snow cover duration and the insulation of permafrost has been added in the first paragraph of Section 15.3.4.1.
15-775	A	19	7			...climate, as a result of a change in albedo. (Robert Jefferies, University of Toronto)	JW: Changed as suggested.
15-776	A	19	7	19	7	Expand "… its influence on local climate through albedo" to "its influence on local climate through albedo and insulation". (Claire Parkinson, NASA Goddard Space Flight Center)	JW: Changed as suggested (and to conform with response to preceding comment).
15-777	A	19	9			(Dye 2002), primarily as' (Peter Johnson, University of Ottawa)	JW: Changed as suggested.
15-778	A	19	14	19	16	Is the author saying that the Greenland ice sheet is still now responding to changes from past millennia? Is there evidence for this? (John Calder, National Oceanic and Atmospheric Administration)	JW: This portion of text has been deleted; changes of the Greenland ice sheet are covered by WG I, Chapter 4.
15-779	A	19	14	19	16	The first half of this sentence is true, but there is evidence that the smaller ice masses of the Canadian Arctic (<100km2) have responded relatively much more dramatically to climate changes of the past 40 years (Cawkwell et al, in preparation) whilst the larger ice caps are responding to changes over the past few centuries (e.g. the Devon ice cap, as reported in Burgess et al 2004, AAAR) and thus it is not a clear cut picture of retreat as is implied here (Fiona Cawkwell, University of Alberta)	JW: This portion of text has been deleted; recent changes of glaciers are more appropriately covered by WG I, Chapter 4.
15-780	A	19	14	19	16	Grammatical error in this sentence - either 'whereas some of…' or 'whereas the sum of…' (presumably the former) (Fiona Cawkwell, University of Alberta)	JW: This portion of text has been deleted.
15-781	A	19	14	19	16	Omit this sentence (Robert Thomas, EG&G Services)	JW: We have omitted it.
15-782	A	19	15			"whereas the some of" delete "the' (Larry Hinzman, University of Alaska Fairbanks)	JW: Sentence has been deleted.
15-783	A	19	15			whereas some of the changes' or 'whereas the changes' (Peter Johnson, University of Ottawa)	JW: Sentence has been deleted.
15-784	A	19	15	19	15	…. whereas some of ….. (Peter Lemke, Alfred Wegener Institute)	JW: Sentence has been deleted.
15-785	A	19	15			Delete “the” (Lloyd Peck, British Antarctic Survey)	JW: Sentence has been deleted.
15-786	A	19	15			For the larger Arctic ice caps, the respopnse time to climate change can be centuries to a millenium or more (ie much longer than decades, though still shorter than for the Greenland ice sheet)	JW: Sentence has been deleted.

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						(Martin Sharp, University of Alberta)	
15-787	A	19	18	19	19	references for Canadian Arctic and Svalbard are needed (Elisabeth Isaksson, Norwegian Polar Institute)	JW: This portion of text has been deleted; recent changes of glaciers are more appropriately covered by WG I, Chapter 4.
15-788	A	19	18			remove comma (Peter Johnson, University of Ottawa)	JW: Sentence has been deleted
15-789	A	19	18			delete “the” (Lloyd Peck, British Antarctic Survey)	JW: Sentence has been deleted.
15-790	A	19	19			remove comma after Scandinavia (Peter Johnson, University of Ottawa)	JW: Sentence has been deleted.
15-791	A	19	19	19	19	Can some references for trends in Canadian Arctic glaciers be given? (Sharon Smith, Geological Survey of Canada)	JW: This portion of text has been deleted; recent changes of glaciers are more appropriately covered by WG I, Chapter 4.
15-792	A	19	22		23	Actually, these glaciers were in fact monitored in the 1990's using remote sensing, with an ~20% increase in melting observed over that decade- see L.C. Smith et al., Geophysical Research Letters, 30(2), 2003. (Laurence C. Smith, University of California, Los Angeles (UCLA))	JW: This portion of text has been deleted; recent changes of glaciers are more appropriately covered by WG I, Chapter 4.
15-793	A	19	23	19	23	"repeated observations of galcier extent"- I assume these are referring to field measurements. What about remote sensing data for this area? (Elisabeth Isaksson, Norwegian Polar Institute)	JW: This portion of text has been deleted; recent changes of glaciers are more appropriately covered by WG I, Chapter 4.
15-794	A	19	25	19	27	[1] On line 26, strike "slowly", and on line 27 replace "rapidly" with "so that overall the ice sheet is growing in height" . [2] On line 27 add Johennesen et al. 2005 to the list of references. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	JW: Changed as suggested.
15-795	A	19	25	19	25	This sentence is far too tantative; everything in Greenland "appears" to be happening. This is highlighted by many recent publications that the authros must be aware of. The reference to "glacier acceleration through enhanced lubrication" IS tentative, and probably incorrect; there is NO evidence for it. Indeed there are observations of ice acceleration following melt events, but only on slow-moving ice, and certainly not on the glaciers that have substantially accelerated. (Robert Thomas, EG&G Services)	JW: We have deleted the portion (and reference) about lubrication, probably to the chagrin of Jay Zwally. We also got rid of the tentative “appears to” in two places.
15-796	A	19	25			A sentence should be added discussing possible impacts of ice loss to the ocean on ocean circulation. (Robert Thomas, EG&G Services)	JW: The linkage between ice sheet discharge and the ocean is noted in Section 15.3.3.
15-797	A	19	26	19	29	This phenomenon of increased thickening in the interior and thinning at the margins is also evident in the Canadian Arctic (Abdalati et al, 2004 JGR 109) comparing laser altimetry surveys over the period 1995-2000, and also from	JW: This is more appropriately discussed in Chapter 4 of WG I, for which the focus is recent cryospheric change.

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						unpublished (Cawkwell) data comparing 2003 IceSat data over the Devon icecap with elevation data derived from 1960 aerial photography (Fiona Cawkwell, University of Alberta)	
15-798	A	19	26	19	29	Interior thickening and marginal thinning is also characteristic of ice caps in Arctic Canada. The Rignot et al (2005) paper is about Antarctica, not Greenland - for which reference to work by Zwally et al or Parizek and Alley would be more appropriate (Martin Sharp, University of Alberta)	JW: See preceding response. The reference to Rignot et al. (2005) has been eliminated. The work of Zwally et al.on the lubrication hypothesis was just trashed by Bob Thomas in comment 15-795 above,
15-799	A	19	27	19	27	put a period after (Krabill et al., 2000). Delete "this" and add "The latter…" (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Period has been inserted. The sentence following it has been reworked in response to comment 15-595 and others above.
15-800	A	19	29	19	30	This seems surprising given ice sheets etc. Where was ice extent greater than now (? On exposed shelves?). Clarify (Roger Barry, University of Colorado)	JW: This comment does not match the cited page/line numbers. Cannot locate the statement in question.
15-801	A	19	29			"and glacier acceleration through enhanced lubrication (Rignot et al., 2005)" This is not a good reference for this particular point. They conclude ice shelf loss not enhance lubrication is the cause. The best reference to make this point is Zwally, H. J., W. Abdalati, T. Herring, K. Larson, J. Saba, and K. Steffen (2002), Surface melt-induced acceleration of Greenland ice-sheet flow, Science, 297, 218-222. 21-4: "but this is not supported by the corresponding measurements of ocean change." There are too few measurements in this region to either support or contradict. (Ian Joughin, Applied physics Lab, University of Washington)	JW: Given the controversy over the lubrication hypothesis (cf. comment 15-595), we have deleted the mention of lubrication. Moreover, this issue is more appropriate to WG I.
15-802	A	19	29			This reference is to a paper on Antarctica not Greenland. (Tavi Murray, University of Wales Swansea)	JW: Reference to Rignot et al. (2005) has been deleted.
15-803	A	19	31	19	31	reword and try to have Lemke in WG1 modify also: Warming, thawing, aand decrease in areal extent of terrain underlain by permafrsot etc. (Jerry Brown, International Permafrsot Association)	JW: Sentence has been reworded as suggested.
15-804	A	19	31	19	43	Again I have to ask if this is based on a steady-state model that does not take into account transient effects refreezing during the winter. I don't understand how the areal extent of permafrost can be reduced to such a degree (up to 35% by 2080) when the active layer thickness increase is 30 to 50%. The appropriateness of using %-change is also questionable. It would be better to show some cases with actual depths in centimeters or meters. (Arne Instanes, OPTICONSULT Consulting Engineers)	JW: We removed the estimates of % decrease of permafrost area, and left the text saying simply that the permafrost area is likely to decrease. For the decreases of active layer depth, we have added a sentence giving the range of increase in units of length (depth).
15-805	A	19	31	19	43	Trends on permafrost still seem to based on modeling rather than on direct observation. Chris Burn (Carleton Univerity and one of the Canadian Northern Research Chairs) gave a presentation at a conference called Rapid Landscape	JW: The online materials are grey literature, while the text refers to a published paper. It is difficult to over-rule the latter by the former.

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						Change (http://www.taiga.net/rapidchange/index.html). He concluded that change to permafrost would be happening more slowly than models were predicting (http://atlas-conferences.com/cgi-bin/abstract/capx-56). (John Streicker, Yukon College)	
15-806	A	19	32			In addition to Lemke et al. in press, I suggest you also cite Euskirchen et al. in press. (Anthony McGuire, University of Alaska Fairbanks)	JW: Reference has been added as suggested..
15-807	A	19	32			An appropriate reference here will be Sazonova, T. S., Romanovsky, V. E., Walsh, J. E., and D. O. Sergueev, Permafrost dynamics in 20th and 21st centuries along the East-Siberian Transect, Journal of Geophysical Research, VOL. 109, D01108, doi:10.1029/2003JD003680, 2004. (Vladimir Romanovsky, University of Alaska Fairbanks)	JW: Reference has been added as suggested
15-808	A	19	32	19	36	What do these percentages refer to? - the actual area underlain by permafrost or the area covered by the permafrost regions? Are these results based on transient simulations or on equilibrium conditions (I.e. do they consider the lag between increases in air temperature and thawing of permafrost?). There can be considerable lag between increases in air temperature and thawing of permafrost especially in peatland areas. (Sharon Smith, Geological Survey of Canada)	JW: Percentages pertaining to changes of permafrost area have been deleted.
15-809	A	19	33	19	34	MUST qualify what is meant by reduction; to what depth. (Jerry Brown, International Permafrsot Association)	JW: We have eliminated the percentages in reference to changes of permafrost area. W e now simply say that "permafrost area .. is likely to decrease during the 21st century". That statement avoids the issue of specific depths.
15-810	A	19	33	19	33	Change "to reduce" to "to be reduced" (Michael MacCracken, Climate Institute)	JW: We have reworded to "…is likely to decrease…"
15-811	A	19	36	19	36	be specific as to which zones. (Jerry Brown, International Permafrsot Association)	JW: Changed to "…in areas that are presently continuous permafrost".
15-812	A	19	37	19	38	sentence needs to be rewriiten; does it mean active layer in next 30 years will vary plus or minus 10-15% ???? (Jerry Brown, International Permafrsot Association)	JW: Sentence has been rewritten.
15-813	A	19	37	19	41	Is this discussion referring to the base of summer thaw (I.e. base of active layer) or the top of the permafrost. Under degrading condiitons and talik development the base of the active layer and top of permafrost will not be the same. In addition, active layer thickness may not change much in ice-rich sediments due to surface settlement but thaw will continue to progress deeper into the ground as warming	JW: Text has been clarified by inserting "(base of the active layer") after "depth of seasonal thawing". We have also added a comment about the dependence of the active layer thickening on ice content. The

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						occurs (see for eg. Smith et al. 2001 - Smith, S.L., Burgess, M.M. and Nixon, F.M. 2001. Response of active-layer and permafrost temperatures to warming during 1998 in the Mackenzie Delta, Northwest Territories and at Canadian Forces Station Alert and Baker Lake, Nunavut; Geological Survey of Canada Current Research 2001-E5, 8 p.) (Sharon Smith, Geological Survey of Canada)	suggested reference is in the grey literature, so we have not included it.
15-814	A	19	39			"middle of the century depth of seasonal thawing" THE depth of seasonal thawing (Larry Hinzman, University of Alaska Fairbanks)	JW: We have inserted the suggested "the".
15-815	A	19	40	19	41	The lead author is quoting his own work. Are there other references that substantiate the model results?. (Jerry Brown, International Permafrsot Association)	JW: References to Euskirchen et al. (2006) and Sazanova et al. (2004) have been added – see responses to reviewer comments 15-806 and 15-807.
15-816	A	19	41	19	43	Impacts on infrastructure will largely depend on ground ice content. Feedbacks to climate system will also be through changes in moisture fluxes/hydrological systems that are related to permafrost changes. Links between permafrost and aquatic/hydrologic systems and climate change are discussed in: 1. Brown, Demuth, M.N., Goodison, B.E., Marsh, P., Prowse, T.D., Smith, S.L. and Woo, M.-K. 2004. Climate Variability & Change - Cryosphere. Chapter 14 in Threats to Water Availability in Canada; NWRI Scientific Assessment Report Series No. 3 and ACSD Science Assessment Series No. 1, National Water Research Institute, Meteorological Service of Canada, Environment Canada, p. 107-116. (Sharon Smith, Geological Survey of Canada)	JW: We have added the point about ground ice – see response to 15-813. Permafrost-hydrology connections are discussed in Section 15.4.1.1 (5th para. of FOD); see also last paragraph of Section 15.4.1.2. We prefer not to add grey-literature references, as this section has references to the refereed literature – including some newly added ones.
15-817	A	19	42			"engineering infrastructure built permafrost" built on permafrost built in permafrost regions? (Larry Hinzman, University of Alaska Fairbanks)	JW: "on" has been inserted (see following comments).
15-818	A	19	42			built 'on' permafrost (Peter Johnson, University of Ottawa)	JW: "on" has been inserted.
15-819	A	19	42			Insert "on" between "built" and "permafrost" (Lloyd Peck, British Antarctic Survey)	JW: "on" has been inserted.
15-820	A	19	42			"… on the engineering infrastructure built ON permafrost …"? (Vladimir Romanovsky, University of Alaska Fairbanks)	JW: "on" has been inserted.
15-821	A	19	45	21	11	A check should be made so that this material agrees with WG I, as there is considerably more discussion there. (Michael MacCracken, Climate Institute)	JW: We have checked for consistency with Chapter 4 of WG I, and there are no contradictions. We have eliminated a paragraph of Section 15.3.4.2 because of overlap with WG I's Chapter 4.
15-822	A	19	45			Section 15.3.4.2 fails to mention the loss of ice shelves and almost-immediate	JW: Recent changes of ice shelves are

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						massive acceleration of their tributary glaciers. This is probably the biggest news from Antarctica since TAR, so why are we skirting it. I fail to see the need for Fig 15.4. Something depicting the far greater changes in the Arctic for the previous section would be far more useful. (Robert Thomas, EG&G Services)	covered by Working Group I -- see Chapter 4, Section 4.6 of WGI. Our chapter is concerned with impacts, vulnerabilities and adaptation, so recent changes of ice shelves are more appropriate to WG I. After considerable discussion at the Merida meeting, the chapter authors agreed to retain Figure 15.4 because its omission would worsen the imbalance between the Arctic and Antarctic in the present chapter.
15-823	A	19	48	19	49	While neglecting a seasonal snow cover might have been permissive in former assessments, the ongoing change in climate, particularly on the Antarctic Peninsula and the sub-Antarctic islands has already led to something like a seasonal snow cover, at least as far as summer melting is concerned. (Manfred Lange, University of Muenster)	JW: This point has been added to the first paragraph of Section 15.4.3.2.
15-824	A	19	48			I would suggest: "Permafrost in ice-free areas, seasonal snow cover, …" (Vladimir Romanovsky, University of Alaska Fairbanks)	JW: Suggested change has been made.
15-825	A	20	1	20	10	The confusion in the Antarctic sea ice "picture" is probably because of the stronger natural regionality in temperature around the southern ocean, (see eg refs in Fisher 2003). Until models can capture the regional differences AND a get a reasonable temporal agreement from the same forcing there is not much chance of their agreeing on detailed projected sea ice changes . (David Fisher, Geological Survey of Canada)	JW: This paragraph has been deleted because it is covered by WG I (Chapter 4). We have retained the comment about the revised thinking on de la Mare's results; cf. Executive Summary and Section 15.2.1.
15-826	A	20	1	20	10	See point No 1 (Massimo Frezzotti, ENEA)	JW: This paragraph is deleted because it is the purview of WG I, Chapter 4.
15-827	A	20	2			the de la Mare work is no longer considered as reliable as what? Some justification for this comment and evidence that it is true should be provided. (Martin Sharp, University of Alberta)	JW: As in the TAR. Have modified sentence about Antarctic sea ice accordingly, and have moved it to Section 15.2.1. Accompanying reference to Ackley et al. (2003) provided the justification.
15-828	A	20	4	20	6	"In distinct contrast to the Arctic, there has been no ubiquitous trend in Antarctic sea ice …" indicates that in the Arctic there has been a ubiquitous trend, and this is simply not the case, as the Arctic also shows periods of increasing as well as decreasing sea ice and marked regional differences. Suggestion: Replace "there has been no ubiquitous trend" by "there is not an overall downward trend". (Claire Parkinson, NASA Goddard Space Flight Center)	JW: Sentence has been modified as suggested. (Sentence now appears in Section 15.2.1).
15-829	A	20	7			Mark the Ross Sea on Figure 15.1	# Accept – DV to check that this is done.

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						(Fiona Cawkwell, University of Alberta)	
15-830	A	20	7			a future a' edit (Peter Johnson, University of Ottawa)	JW: Paragraph has been deleted to meet length limits.
15-831	A	20	10	20	10	add Jacobs and Comiso (1997) in the reference (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Paragraph has been deleted to meet length limits. Suggested reference is pre-TAR, so we prefer to save the reference space for post-TAR references.
15-832	A	20	12			?local climatic cooling? In cold season? (Roger Barry, University of Colorado)	JW: This phrase does not appear on p. 20. I cannot find it in the FOD, even using "Find". (If it refers to p. 9, para. 2, of the FOD, we deleted that paragraph.
15-833	A	20	16	20	17	How does this square with land area limited by Arctic Ocean? Cf lines 37-8 below. (Roger Barry, University of Colorado)	JW: Not sure what this is referring to. On p. 20, lines 16-17 of FOD, there is a figure -- no text.
15-834	A	20	39	20	39	cite specific references about model studies of sea ice in the Antarctic (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Added reference to Parkinson et al. (2006)
15-835	A	20	39			Better phrasing - A definit shortcoming exhibited in several models is … (Gordon McBean, University of Western Ontario)	JW: Text changed as suggested, although I liked the old wording better.
15-836	A	20	40	20	44	An appropriate reference here would be Arzel, O., T. Fichefet, and H. Goosse, 2005: Sea ice evolution over the 20th and 21st centuries as simulated by the current AOGCMs. Ocean Modelling (accepted). (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	JW: Reference has been added.
15-837	A	21	1	21	4	What are the nature of these ocean changes - currents, temperature? (Fiona Cawkwell, University of Alberta)	JW: Wording has been changed to "…measurements of ocean temperature".
15-838	A	21	1	21	4	this sentence appears to contain a contradiction? (Peter Convey, British Antarctic Survey)	JW: The contradiction is the point of the sentence in question. Also, see preceding response.
15-839	A	21	1	21	4	The recent paper in GRL by Meredith & King shows a warming of the Southern Ocean in this region in the last 50 years. Does this not contradict this sentence? (Lloyd Peck, British Antarctic Survey)	No, There is no contradiction. Meredith and King's result is from the Bellingshausen Sea and not the Amundsen Sea.
15-840	A	21	1		11	Again, the buttressing/ice flow/sea level effect should be mentioned HERE. (Laurence C. Smith, University of California, Los Angeles (UCLA))	JW: As noted in response to 15-39, this effect is included in Case Study 15.6.3, pp. 40-41.
15-841	A	21	3			ADD: … climate through the albedo-temperature feedback mechanism (Roger Barry, University of Colorado)	JW: This comment does not seem to apply to FOD's p. 21, line 3. It appears that it is directed at some other page/line, which we cannot determine.

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15-842	A	21	5	21	11	There is some repetition in this section relative to earlier statements (Robert Jefferies, University of Toronto)	JW: Earlier discussion in Section 15.2 has been shortened
15-843	A	21	7	21	8	….. A future deglaciation …. (Peter Lemke, Alfred Wegener Institute)	JW: Fix has been made via response to following comment.
15-844	A	21	7			"we can expect in the future a …" (Gordon McBean, University of Western Ontario)	JW: Text has been changed as suggested.
15-845	A	21	9	21	9	rewrite as "the thickness of some parts of the East Antarctic ice…." (Josefino Comiso, NASA Goddard Space Flight Center)	JW: Some element of caution is required here since there are no in situ confirmations that the satellite data are absolutely correct – see following comments by other reviewers.
15-846	A	21	9	21	11	There is no evidence from well dating ice cores of an increase accumulation rate in East Antarctica. Increase in accumulation is mainly evident in the central part of the plateau or at dome sites, where the ablation process have less impact on snow accumulation (Frezzotti et al., J. Glaciol, in press) . An increase in accumulation was observed at South Pole, in Wilkes Land, at Talos Dome, in Lambert Basin (e.g. Mosley-Thompson et al., 1999, Morgan et al. 1991, Peel 1992, Stenni et al., JGR 2002; Jawen et al., Ann. Glaciol., 1999), decrease or no significant trend pattern have been observed in Dronning Maud Land, with no significant trend or negative (Oerter et al., Ann. Glaciol. 1999, 2000; Isaksson et al., Ann. Glaciol. 1999; Graf et al., Ann. Glaciol. 1999, Hofstede et al., J. Glaciol. 2004; Karlof et al., JGR 2000). The increase accumulation suggested by Davis et al. 2005 could be related to artefact. (Massimo Frezzotti, ENEA)	JW: We believe that sufficient caution in the results of that paper are suggested by the phase “seem to indicate”.
15-847	A	21	9	21	11	Maybe add a sentence " However, there is still a lack of in situ measurements that can support these results." (Elisabeth Isaksson, Norwegian Polar Institute)	JW: We believe that sufficient caution in the results of that paper are suggested by the phase “seem to indicate”.
15-848	A	21	11			No reference is made to ice shelves and their significance to the Antarctic system - from a cryospheric, oceanic, climatic and biological sense these are important components and with their breakup resulting in potential changes in the dynamics of land ice, impacting on ocean currents, affecting subsequent sea-ice formation and breakup, changing the local microclimate, having implications for penguin movements etc there seems to be potential to include these entities (Fiona Cawkwell, University of Alberta)	JW: This is dealt with in the text box, since it is (for the present) a purely Antarctic Peninsula issue.
15-849	A	21	14			Comment on Section 15.4. I would replace "will" with "could" in most places. In other places "should" might also be appropriate. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Text has been altered with appropriate lexicon.
15-850	A	21	16			This also raises the other point that there are no Antarctic terrestrial or freshwater	There is some material about this issue in the

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						sections. Can I suggest that sections matching 5.4.1 (freshwater) and 5.4.2 (terrestrial) are written for the Antarctic? (Michael Usher, University of Stirling)	Antarctic Peninsujla case study, and we view that the present level of coverage is sufficient to represent knowledge and progress in this field of study
15-851	A	21	21	21	21	why not use term Subarctic instead or in additon to temperate (Jerry Brown, International Permafrsot Association)	Text changed to "southerly"
15-852	A	21	21	7	7	delete second "a" at end of line (Marybeth Long Martello, Harvard University)	Deleted as suggested.
15-853	A	21	21	21	22	Catchments of the largest Arctic' rivers: Ob' -2,990,000 sq. km; Yenisey-2,580,000 sq. km; Lena -2,490,00 sq. km; Mackenzie- 1,802,000 sq. km and Yukon River (855,000 sq. km) (Gorshkov S.G. (editor) (1980) World Ocean Atlas, vol. 3, Arctic Ocean; Pergamon Press, Oxford, 184 pp.; Mark Nuttall (editor) (2005) Encyclopedia of the Arctic, vols.1-3, Routledge, New York and London). It is better to write: "These include, five of the Arctic's largest river catchments, the Ob', Yenisey, Lena, Mackenzie and Yukon that act …..". (Vladimir Pavlov, Norwegian Polar Institute)	Order of rivers has been changed to alphabetical listing but "world's largest" has been retained to show global importance of these systems.
15-854	A	21	23		24	For such systems (ADD COMMA) basin-wide effects (ADD COMMA) especially those from the south (ADD COMMA) will be critical in determining both individual and cumulative impacts. (Larry Hinzman, University of Alaska Fairbanks)	Commas added as suggested
15-855	A	21	23			No, the thermokarst development causes lake growth, not drainage. CHANGE phrase "...thermokarst development and surface to groundwater drainage..." TO "...enhanced drainage to groundwater..." (Laurence C. Smith, University of California, Los Angeles (UCLA))	Text changed as suggested.
15-856	A	21	26	21	27	A sentence that explains flow impoundment and regulation would be useful (Josefino Comiso, NASA Goddard Space Flight Center)	Insufficient space to embellish on terms impoundment and regulation but see additional text in the following comment.
15-857	A	21	34	21	35	This needs clarification. (Gordon McBean, University of Western Ontario)	Clarification text has been added "…because of the flow dampening effects producted by water storage and release through…"
15-858	A	21	34	21	36	This needs more explanation (Vladimir Romanovsky, University of Alaska Fairbanks)	Addressed in comment above.
15-859	A	21	37	21	38	delete "considered" and rewrite as "is associated with relatively low emittion of greenhouse…" (Josefino Comiso, NASA Goddard Space Flight Center)	Text changed as suggested but using "…low emission of greenhouse…"
15-860	A	21	44	21	44	it is not clear what "this redistribution" is referring to (Josefino Comiso, NASA Goddard Space Flight Center)	Text chaned to "…this seasonal redistribution of flow…"

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15-861	A	21	46			Sveta Berezovskaya, Daqing Yang, Larry Hinzman. 2005. Long-term annual water balance analysis of the Lena River. Global and Planetary Change 48:84– 95. A HUGE gap in this chapter is a discussion on the role of wildfire! Over half of the severe fire years in Alaska's 56-year fire record have occurred since 1990. Summers with extensive wildland fires now occur more frequently. (Larry Hinzman, University of Alaska Fairbanks)	#Inserted The bulk of the boreal forest is located in the regional chapters covering N. America and Asia. We will check that this issue is covered in the other chapters.
15-862	A	21	47			I am not familiar with the word "freshet" – it may well be in common use within a particular discipline, region or country, but I suspect will not be widely recognised by the readers of this report. (Peter Convey, British Antarctic Survey)	"freshet" changed to "major spring flows"
15-863	A	21	49	22	2	cite Tingjun Zhang, et al. (2005), Spatial and temporal variability in active layer thickness over the Russian Arctic drainage basin, J. Geophys. Res., 110, D16101, doi:10.1029/2004JD005642. (Larry Hinzman, University of Alaska Fairbanks)	Citation added.
15-864	A	21	49	22	2	No. J.W. McClelleland et al., (JGR, 2004, cited elsewhere in this chapter) showed that flow additions from melting permafrost are too small to be a signficant source of the observed discharge increases. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Text deleted to focus only on seasonal redistribution of flow.
15-865	A	21	50	21	50	prefer a reference for this statement (Jerry Brown, International Permafrsot Association)	Reference has been added as per 864 above.
15-866	A	21				Balance. Around half the text should be on Section 15.4 Impacts. Here there are around 17 pages for section 15.4 and 41 in total. This is about right, but it would be good if the shortening is concentrated outside Section 15.4. (Jean Palutikof, Hadley Centre)	No comment
15-867	A	22	1	22	1	insert "ground" between melting and ice. (Jerry Brown, International Permafrsot Association)	Text inserted as suggested.
15-868	A	22	1	22	2	For clarity - indicate that it is melting of ground ice. There will be an increase in the subsurface component of water flow as permafrost degrades which can affect the seasonality of the response (clarification of what altered flow pathways refers to) (Sharon Smith, Geological Survey of Canada)	Text clarified to indicate melting of ground ice and regarding flow pathways.
15-869	A	22	2			flow additions through the contributions of melting ice and because of altered flow pathways that can affect the seasonality of the response. (Add Zhang, T. et al. (2005), Spatial and temporal variability in active layer thickness over the Russian Arctic drainage basin, J. Geophys. Res., 110, D16101, doi:10.1029/2004JD005642.) as a citation.	Citation added and text changed as indicated above.

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						(Larry Hinzman, University of Alaska Fairbanks)	
15-870	A	22	4	22	5	revise: tundra ponds and lakes and deeper thermokarst (Jerry Brown, International Permafrsot Association)	Comment unclear; thermokarst modifier deleted.
15-871	A	22	4	22	5	complete the sentence. May add in the end a phrase like: "that can have significant impact on climate." (Josefino Comiso, NASA Goddard Space Flight Center)	Scale is an issue regarding significance but since focus is on impacts, addition not included.
15-872	A	22	4			Could the nature of lentic system be defined - term unfamiliar (Julian Dowdeswell, University of Cambridge)	Term defined.
15-873	A	22	4			give a short definition of thermokarst (Gordon McBean, University of Western Ontario)	Term has been deleted here and in subsequent paragaphs
15-874	A	22	4			What is lentic? Define please. (Gunter Weller, University of Alaska)	
15-875	A	22	9	22	14	I don't understand the logic here. There are paleo records of changes in the biota since the end ot the Little Ice Age. These changes occur since 1850 (according to the references here), so what are you getting at here? Maybe it is just the way it is written, but I dont follow your point. Incidently, there was a paper last summer in PNAS by Smol et al that is a better reference than those listed. But what does the second sentence mean? "In contrast, systems without such warming...". What are you saying here? This study is based on 2 short cores from one location. And, in fact, these cores do show some change, if you look closely. I realize the ACIA has a box (8.1, p 370 in the online version) about there being "long-term climate stability" in northern Quebec/ Labrador, but I dont know where they got this, it is quite contrary to the facts. (Konrad Gajewski, University of Ottawa)	Section has been shortened and re-written to clarify ambiguity. Two new refrences have been added.
15-876	A	22	9	22	14	Can you rule out other possible environmental influences on lake/pond ecosystems - for instance increased atmospheric N depsition in the Arctic? (Martin Sharp, University of Alberta)	Agreed that there may be other possible environmental influences. However, we focused on identify key climate-related factors. Text has been modified to clarify.
15-877	A	22	12	22	12	change "ice cover duration" to "snow cover duration" (Josefino Comiso, NASA Goddard Space Flight Center)	Ice cover durationis correct in this case.
15-878	A	22	16			should first reference to lotic actually be lentic? (Peter Convey, British Antarctic Survey)	Text is correct.
15-879	A	22	16			Could the nature of lotic system be defined - term unfamiliar (Julian Dowdeswell, University of Cambridge)	Term defined.
15-880	A	22	16			give a short definition of lotic (Gordon McBean, University of Western Ontario)	Term defined.
15-881	A	22	16			What is lotic? Define please.	Term defined.

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						(Gunter Weller, University of Alaska)	
15-882	A	22	21	22	21	thawing not melting (Jerry Brown, International Permafrsot Association)	Text changed as suggested.
15-883	A	22	21			"Melting of surface permafrost…" should be "Thawing of surface permafrost…" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed as suggested.
15-884	A	22	21	22	25	Shallow permafrost would be a better term than surface permafrost. Can some references be provided for North America as well that discuss lake drainage (Work by Hinzman, Duguay?) (Sharon Smith, Geological Survey of Canada)	Text changed and references for North America added.
15-885	A	22	22	22	22	deeper thaw (Jerry Brown, International Permafrsot Association)	Text changed as suggested.
15-886	A	22	22			"… more extensive and deeper melt…" should be "… more extensive and deeper thaw…" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed as suggested.
15-887	A	22	24	22	25	Could the shrinkage be in part due to more evaporation in the warmer south? (Josefino Comiso, NASA Goddard Space Flight Center)	Possibly but not considred in cited literature to form conclusion.
15-888	A	22	47	22	47	replace "vanished" with "disappeared". If solid evidence that they drained; would be better to use "drained" (Jerry Brown, International Permafrsot Association)	The term “vanished” was employed by the original authors.
15-889	A	22	50	22	50	thawing uder the lakes (Jerry Brown, International Permafrsot Association)	Not necessarily since drainage could be lateral.
15-890	A	22	50			"thawing has driven the observed losses" thawing is probably also responsible for lake gains in northern regions. (Larry Hinzman, University of Alaska Fairbanks)	Text has been changed to “observed changes”
15-891	A	23	0	26	0	The impact of Greenland is somewhat understated here. Much is made of 2 km3/yr change in flux in river discharge, yet results suggest discharge from Greenland is increasing at a faster rate (e.g. Krabill et al., 2004) Krabill, W., et al. (2004), Greenland Ice Sheet: Increased coastal thinning, Geophys. Res. Lett., 31, doi:10.1029/2004GL021533. Over the course of a few years, Jakobshavn Isbrae alone increased its discharge by more than 20 km3/yr (Joughin et al., 2004). Joughin, I., W. Abdalati, and M. Fahnestock (2004), Large fluctuations in speed on Greenland's Jakobshavn Isbrae glacier, Nature, 432, 608-610. (Ian Joughin, Applied physics Lab, University of Washington)	DGV and TP to consider – noting reference to paper Dyergurov and Carter, 2004
15-892	A	23	10	23	10	Comments about river discharges changing under climate change scnearios are repeated on severa occasions. While there is a contextual grouping that makes this sort of thing inevitable, if the desire is to keep delivery sharp and to reduce space, organization should be modified to reduce repetition.	Text edited to avoid repetition.

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						(David E Atkinson, University of Alaska Fairbanks)	
15-893	A	23	10			"also" is not in right place (Vladimir Romanovsky, University of Alaska Fairbanks)	Placement corrected.
15-894	A	23	16			change "suggesting" to "suggest" (Larry Hinzman, University of Alaska Fairbanks)	Original text retained.
15-895	A	23	22	23	30	rewrite sentences, too complex (Peter Johnson, University of Ottawa)	Complexity reduced.
15-896	A	23	23			such as a consequence of..sea-ice (Robert Jefferies, University of Toronto)	Text eliminated.
15-897	A	23	26			Increase in river export of freshwater (2 cu km/yr over last century) could be compared to the increase in ice discharge from Greenland. 60 cu km/yr between 1993 and 1999 to 80 cu km/yr between 1997 and 2003 (Krabill et al., GRL, 32, 2003) (Robert Thomas, EG&G Services)	DGV and TP to consider – noting reference to paper Dyergurov and Carter, 2004
15-898	A	23	27	23	27	thaw not melt (Jerry Brown, International Permafrsot Association)	Text chaned as suggested.
15-899	A	23	27			conflicts with page 21, line 49 (Larry Hinzman, University of Alaska Fairbanks)	Text clarified.
15-900	A	23	27	23	27	Permafrost melt or permafrost thaw? (Arne Instanes, OPTICONSULT Consulting Engineers)	Text changed as suggested.
15-901	A	23	27			should be "permafrost thaw" instead of "permafrost melt" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text chaned as suggested.
15-902	A	23	29			cite Sveta Berezovskaya, Daqing Yang, Larry Hinzman. 2005. Long-term annual water balance analysis of the Lena River. Global and Planetary Change 48:84– 95. (Larry Hinzman, University of Alaska Fairbanks)	Referenced included as suggested.
15-903	A	23	31			should be "permafrost thaw" instead of "permafrost melt" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text chaned as suggested.
15-904	A	23	38		40	Present understanding is that the changes in the THC are mostly due to the changes in the surface heat fluxes (WG1, Chapter 10, p. 22) (Jari Haapala, Finnish Institute of Marine Research)	Noted but concern still exists in the literature about freshwater influence.
15-905	A	23	42			ice cover (Robert Jefferies, University of Toronto)	Text changed.
15-906	A	23	42	23	50	Are increased icings associated with greater winter subsurface flow (related to permafrost thaw and thicker active layer) likely to be a factor in ice jamming? (Sharon Smith, Geological Survey of Canada)	Possibly but no available literature to base discussion.
15-907	A	23	44			Prowse et al, in prep. I guess that it means in preparation, however it should be in press by the end of the year, or not?. Also Reist et al in pg 24 line 49.	Papers only included if “in press” by final review stage or material will be removed or

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Jorge Carrasco, Dirección Meteorológica de Chile)	refererence made to related publications, e.g., ACIA 2006
15-908	A	23	44	23	44	change "Two" to "Three" since there are 3 listed (Josefino Comiso, NASA Goddard Space Flight Center)	Changed made as suggested.
15-909	A	23	44			here and following - reference to a publication in prep. - should be at least a gray lit or submitted. (Gordon McBean, University of Western Ontario)	Papers only included if "in press" by final review stage or material will be removed or refererence made to related publications, e.g., ACIA 2006
15-910	A	23	44			I hope that Prowse et al., in prep has been submitted and is in press. Other "in prep" and "submitted" papers cited in the chapter should be examined to see if they can be cited in the revision. (Anthony McGuire, University of Alaska Fairbanks)	Papers only included if "in press" by final review stage or material will be removed or refererence made to related publications, e.g., ACIA 2006
15-911	A	23	47		48	It is not clear that the severity of spring floods will increase. Other studies have shown that an earlier onset of spring warming will lead to more thermal, rather than mechanical, break-up of river ice cover, which would lead to LESS severe floods and fewer ice-jams. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Text about breakup clarified..
15-912	A	23		42		I have no comments on the projections except to note different styles of expressing uncertainties in the different sections, I.e. "will occur" vs, "is likely yo occur". Should adopt a uniform style such as used by the ACIA (Gunter Weller, University of Alaska)	noted
15-913	A	24	2	24	49	Syvitski has published on climate change effects on arctic river sediment discharge - every 2C warming gives 22% increase in flux of sediment. (Syvitski, J.P.M., 2002) Sediment discharge variability in Arctic rivers: implications for a warmer future. Polar Research, 21, 323-330). This could have significant effects on shelf water turbidity, primary production, benthic carbon flux and the marine food web. (Philip Hill, Geological Survey of Canada)	Concept and reference has been included.
15-914	A	24	2	24	2	… potential to affect …. (Peter Lemke, Alfred Wegener Institute)	"effect" as in effecting a change, appropriate in this case
15-915	A	24	7	24	14	Would an increase in vegetation cover affect the organic matter content of soils and would this be likley to increase the catchment retention of persistent organic pollutants that show a strong tendency to bind to organic matter? (Martin Sharp, University of Alberta)	Possibly but no available published literature to base conclusions.
15-916	A	24	12			Hinzman et al, 2005 (Larry Hinzman, University of Alaska Fairbanks)	Citation changed.
15-917	A	24	14			Chapter 15.4.1.2 Impact on physical regime A reference should be given at the end of the sentence!	Comment misplaced – no response

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						(Geir Wing Gabrielsen, The Norwegian Polar Institute)	
15-918	A	24	16	24	24	Warming of permafrost can result in unstable banks and slopes and increased erosion which can lead to increases in sediment supply. (Sharon Smith, Geological Survey of Canada)	Accepted, text changed
15-919	A	24	20			prey (Roger Barry, University of Colorado)	Refers to page 32, line 17.
15-920	A	24	28	24	30	Again, this seems like a very general statement with little support. Sure it is logical, but has this been quantified or modelled? (Konrad Gajewski, University of Ottawa)	Support provided through citations, particularly review work conducted for Arctic Climate Impact Assessment 2006
15-921	A	24	28	26	23	Much of these conclusions in this section are only supported by "in prep" manuscripts. (Elisabeth Isaksson, Norwegian Polar Institute)	Papers only included if “in press” by final review stage or material will be removed or refererence made to related publications, e.g., ACIA 2006
15-922	A	24	30	24	49	Are the "in prep" references allowed? On This page and the subsequent page much of the evidence to support the statements is based on unpublished studies. The statements on these two pages could be reduced without loss of information. (Robert Jefferies, University of Toronto)	Papers only included if “in press” by final review stage or material will be removed or refererence made to related publications, e.g., ACIA 2006
15-923	A	24	30		32	See previous comment - can't have it both ways. The possibility of increased OR decreased spring flooding should be mentioned in both of 15.4.1.2 and 15.4.1.3. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Text revised and clarified.
15-924	A	24	31			"decreased severity of ice breakup"? (James McCarthy, Harvard University)	Text is correct.
15-925	A	24	34	24	35	systems that freeze to the bottom are likely uncommon since as soon as the ice forms at the surface, the liquid water underneath gets protected because ice is such a good insulator (Josefino Comiso, NASA Goddard Space Flight Center)	Portions of arctic rivers do freeze to the bed despite ice insulation.
15-926	A	24	44	24	45	Is there real evidence of this? Is the change in ice thickness projected really going to make a quantitative difference, in systems that today have 2 m of ice in winter? Is there any evidence that the projected changes are great enough to have a quantitative impact on lake circulation, etc? (Konrad Gajewski, University of Ottawa)	Support provided through citations, particularly review work conducted for Arctic Climate Impact Assessment 2006
15-927	A	24	46	24	47	To say that a change would "affect biogeochemical processes" seems to be so vague an assessment of impact as to be not worth saying (Martin Sharp, University of Alberta)	Agree but important to note. Insufficient space to identify all affected processes. Text changed to indicated “key” processes.
15-928	A	24	47	24	49	It depends on how warm is warm! In the Arctic, the water will still be relatively cold. (Josefino Comiso, NASA Goddard Space Flight Center)	Text is referring to threshold temperatures that are likely to be reached even if relatively “cold” compared to other regions. Moreover,

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							summer temperatures likely to be warm even by these standards.
15-929	A	25	1	25	1	thawing not melting (Jerry Brown, International Permafrsot Association)	Text changed as indicated.
15-930	A	25	1			should be "permafrost thawing" instead of "permafrost melting" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed as indicated.
15-931	A	25	1	25	20	I didn't find this very satisfactory. It outlines connections between processes but the statements about rates, magnitudes and directions of change are too vague to be useful to policy makers. If the issue is that the complexity of the systems and the diversity of forcings to which they are subjected is so complex and/or poorly known as to make prediction impossiblethen perhaps it would be better to say this and explain why than to devote a lot of space to motherhood statements that are surely obvious. (Martin Sharp, University of Alberta)	Paragraph cites ACIA and related references where the level of certainty is clearly defined with respect to these statements (most are “likely” to “high likely”)
15-932	A	25	7	25	9	Many of these systems are extremely unproductive today and are oxygen saturated all through. So are the projected changes large enough to cause anoxia? (Konrad Gajewski, University of Ottawa)	Agreed for some regions/conditions. Some confusion has probably arisen because of differing views of the definition of what is “arctic”. Here as in the ACIA, high-latitude boreal situations are also evaluated. This makes the range of potential responses and also the base conditions very wide (e.g.., simple latitudinal variation). This then allows for many possible future impact/effect scenarios. Text has been written to try and reflect this. Note also that an increase in probability of anoxia/hypoxia will occur with increasing sedimentation and affect currently unproductive systems.
15-933	A	25	12		13	Enhanced decomposition..." this statement can now be supported by the recent paper "FREY, K.E., AND L.C. SMITH, Amplified carbon release from vast West Siberian peatlands by 2100, Geophysical Research Letters, 32, L09401, doi:10.1029/2004GL022025, 2005. (Laurence C. Smith, University of California, Los Angeles (UCLA))	TRC to update Maggan to get papers. References will then be added as appropriate There is another relevant GRL paper just out that caught some media attention (in Denmark anyway). Lawrence, D. M., and A. G. Slater (2005), A projection of severe near-surface permafrost degradation during the 21st century, *Geophys.*

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							Res. Lett., *32*, L24401, doi:10.1029/2005GL025080. Maggan: we should have as of the new year on-line access to GRL. So these should both be possible to download now. Otherwise shout at Robin.
15-934	A	25	18	25	20	Check sentence here. (David E Atkinson, University of Alaska Fairbanks)	Text corrected.
15-935	A	25	18	25	18	as permafrost thaws with associated loss of ground ice (Jerry Brown, International Permafrsot Association)	Text changed as suggested.
15-936	A	25	18			Permafrost thaws, ice melts…. (Larry Hinzman, University of Alaska Fairbanks)	Text changed as suggested.
15-937	A	25	18	25	19	coupled' (Peter Johnson, University of Ottawa)	Text corrected.
15-938	A	25	18	25	20	Something is missing from this sentence (James McCarthy, Harvard University)	Text corrected.
15-939	A	25	18	25	18	Time scale of these processes will be very different for continuous and discontinuous permafrost zones (Vladimir Romanovsky, University of Alaska Fairbanks)	Agreed but insufficient space to elaborate on regional differences.
15-940	A	25	18			I would suggest: "As permafrost further thaws and ground ice melts, …" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text modified as suggested.
15-941	A	25	18	25	19	The sentence is unclear - is it meant to say surface and subsurface waters will become increasingly coupled? (Sharon Smith, Geological Survey of Canada)	Text corrected.
15-942	A	25	19	25	19	"couple and drain" is not an easy concept to understand. Does erosion occur?? (Jerry Brown, International Permafrsot Association)	Text clarified.
15-943	A	25	19	25	19	the word "douple"does not belong here, I think (Josefino Comiso, NASA Goddard Space Flight Center)	Text corrected.
15-944	A	25	19			change couple to coupled (Larry Hinzman, University of Alaska Fairbanks)	Text corrected.
15-945	A	25	19	25	19	Change "couple" to "coupled" (Michael MacCracken, Climate Institute)	Text corrected.
15-946	A	25	19			“couple” should be “coupled”. (Lloyd Peck, British Antarctic Survey)	Text corrected.
15-947	A	25	22	25	33	"presently" used to mean "right now" is technically an archaic form; "currently" should be used.	Disagree: see Websters definition of use of term over time.

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						(David E Atkinson, University of Alaska Fairbanks)	
15-948	A	25	22	25	23	This statement makes sense of course, but one could argue that dispersal constraints, etc will stop these migrations, etc. I don't believe that, but the point is that this statement, unsupported, adds little to the discussion. There are studies that demonstrate movement of species, why not add some citations? (Konrad Gajewski, University of Ottawa)	Agree; text has been modified and relevant reference added.
15-949	A	25	22	25	39	Many of the key references in this section are papers in prep. Their titles include the word "potential effects". Hopefully the references will firm up. Nevertheless, the tone of the paragraph is highly speculative. While acceptiong that section 15.3.3 states that any assessment of impacts on marine ecosystems is going to be speculative, there needs to be explicit expression of the level of confidence for the projected changes. (Philip Hill, Geological Survey of Canada)	Papers only included if "in press" by final review stage or material will be removed or refererence made to related publications, e.g., ACIA 2006
15-950	A	25	22	25	39	If any of these changes can be observed already. If so, it will be very appropriate to give some examples to distinguish between observed facts and possible projections (Vladimir Romanovsky, University of Alaska Fairbanks)	Citations linked to ACIA-based publications as noted above.
15-951	A	25	22	25	39	I think that this paragraph misses some important points. Some species as stated will move northwards, but others could be introduced intentionally or unintentionally by people. These might become the invasive species of the future, and hence there is a risk factor to be considered from non-native species. Also, the paragraph does not mention barriers. Some species might not be able to move northwards due to barriers – either the shore of the Arctic Ocean or their inability to move from lake to lake. (Michael Usher, University of Stirling)	Existing text has been clarified and embellished.
15-952	A	25	23	25	26	These results of Reist et al are provocative, and elaboration needs to be provided if such weight is going to be put on a citation that is "in prep" (James McCarthy, Harvard University)	Papers only to be included if "in press" by publication date or material will be removed or reference made to related publications, e.g., ACIA 2006.
15-953	A	25	26	25	26	replace "As well as fishes" with "Similarly" (Josefino Comiso, NASA Goddard Space Flight Center)	Text changed as suggested.
15-954	A	25	38	25	39	this statement appears to be highly speculative (Josefino Comiso, NASA Goddard Space Flight Center)	Supporting reference from ACIA 2006 added.
15-955	A	25	45	25	46	Dams for containment of tailings, sewage should also be mentioned here. (Sharon Smith, Geological Survey of Canada)	Text added as suggested.
15-956	A	26	1			delete "In arctic regions," (Larry Hinzman, University of Alaska Fairbanks)	Text delted as suggested.
15-957	A	26	5			Is it a traditional "practice"?	Accepted- edited to "…and spring is

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						(Gordon McBean, University of Western Ontario)	considered to be a traditional practice, on the same….”
15-958	A	26	14	26	23	Transportation systems (eg importance of Mackenzie River) should also be mentioned in the discussion of impacts on human systems, economies etc. (Sharon Smith, Geological Survey of Canada)	Addition to be in infrastructure section
15-959	A	26	26			there appears to be no reference to the recent Millenium Ecosystem Assessment within this section, which would appear to be very relevant, and contains a main chapter on polar ecosystems. (Peter Convey, British Antarctic Survey)	It is referenced as Chapin et al 2005
15-960	A	26	26			This also raises the other point that there are no Antarctic terrestrial or freshwater sections. Can I suggest that sections matching 5.4.1 (freshwater) and 5.4.2 (terrestrial) are written for the Antarctic? (Michael Usher, University of Stirling)	DGV – we do not believe that there is sufficient space for such sections, and that compared to the Arctic, and in the light of recent research progress that they do not warrant more space in this report
15-961	A	26	30	26	30	rewrite as "Climate changes since the last ice age (~20,000 years)…" (Josefino Comiso, NASA Goddard Space Flight Center)	NO: the Ice Age is considered to have ended 10,0000 years ago in some places
15-962	A	26	30	26	33	I thought arctic spp diversity is low because of the nature of the environment, not necessarily due to extinction events (diversity energy hypothesis). Also, something is not right with the third sentence "Also, ecosystem extent is now less…". In Canada, anyway most of what is now tundra and polar desert was covered by ice at full glacial, and south of the ice sheet was mostly forested, so where was great extent of the arctic ecosystem at that time? If you mean in Siberia, or perhaps Alaska, then you should state that. (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-963	A	26	31	26	32	That large mammals are more vulnerable to change than in the past is not a clear concept to me. Justification for this statement is needed. (Philip Hill, Geological Survey of Canada)	Accepted – text modified
15-964	A	26	31	26	31	the low species diversity is mainly caused at a much longer time scale than 20000 yrs - as can be understood from the current writing. (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-965	A	26	31	26	32	reference to support the assertion of past extinction events (Peter Johnson, University of Ottawa)	Accepted – text modified
15-966	A	26	32	26	32	I'm no marine biologist, but why would large mammals be more susceptible now than at some other time? (David E Atkinson, University of Alaska Fairbanks)	See 15 - 963
15-967	A	26	32	26	33	don't understand how ecoystem extent is less now than duirng glacial period. Needs an explanation.	Accepted – text modified

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						(Jerry Brown, International Permafrsot Association)	
15-968	A	26	32	26	33	This is too general. Some ecosystem had a more dominating role and others were less dominating (Annika Hofgaard, Norwegian Institute for Nature Research)	No action: no space for more detail
15-969	A	26	32	26	32	"….general more vulnerable to change than in the past." This is hard to understand. (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-970	A	26	32			What is special about this climate change that make mammals "more vulnerable," as opposed to past climate changes? Please elaborate, explain, or cite. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Accepted – text modified
15-971	A	26	33			Given the low density of populations and infrastructure in both the Arctic and Antarctic, "habitat fragmentation" in those areas should be minimal. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	I disagree: appropriate reference added
15-972	A	26	36	26	41	Has this TEK insight been independently validated? If not, does it merit mention here? (Martin Sharp, University of Alberta)	TEK cannot be validated in the same way as science knowledge but it is still valuable as acknowledged in a cross-cutting theme
15-973	A	26	44	26	44	The cited paper does not conclude that - it concludes on a relationship between snow and the occurrence of cycles (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-974	A	26	45	26	46	These also stand out as needing rferences or justification. To say something has declined to extinction is a pretty heavy statement to make without explicit justification. (Philip Hill, Geological Survey of Canada)	References added
15-975	A	26	45	26	46	it should be mentioned that a large part of this is due to human interference in ecosystems, e.g. landuse changes and regional extinction of main predators (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-976	A	26	45			Latin binomials needed (Robert Jefferies, University of Toronto)	TVC to check
15-977	A	26	47	26	49	Three "manys" in 3 lines (Robert Jefferies, University of Toronto)	Accepted – text modified
15-978	A	26	47	26	48	I know of no good examples of arctic bird populations having been demonstrated to decline due to climate change in the Arctic. It is quite another thing, what will happen in the future. Please see attached MS on arctic shorebirds submitted to ARCTIC. (Hans Meltofte, National Environmental Research Institute)	Disagree: some examples exist: references added
15-979	A	26	47			Please update the Stroud et al., 2004 reference, it is currently incomplete in the bibliography (Laurence C. Smith, University of California, Los Angeles (UCLA))	Reference completed

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15-980	A	26	49	27	2	"Wild herds of Russian caribou/reindeer have been reduced over the last 10 years from 2 to 1 million (Baskin, 2000) whereas populations of herded reindeer have increased, mainly due to social and cultural factors." This is actually backwards. It is the domestic herds which have declined all across northern Russia since 1991, with the sole exception of the Yamal-Nenets Autonomous Okrug, where domestic herds have increased dramatically in size. Many of the formerly domestic herds in places like Chukotka seem to have been absorbed by neighboring wild herds, much like as has happened on the Seward Peninsula in Alaska, where the Western Arctic Herd has absorbed thousands of domestic animals from private herds on the peninsula. I suggest a closer re-reading of the Baskin (2000) paper that was cited. (Bruce Forbes, University of Lapland)	Agreed – text modified
15-981	A	26	49	27	4	Recently at the Snowchange conference in Alaska, (Sep 2005 Indigenous observations of climate change http://www.snowchange.org/), a researcher from Chukotka gave a presentation where he described the loss of the 1 million reindeer in Russia over the last decade. This Chukchi gentleman said that the loss was due to unexpected and repeated seasons of melt leading to ice on snow events, and bad planning. His description of the herd sounded like a domestic herd (e.g. with decisions to cull in a particular steer / bull ratio)? The reference you have here says it's the wild population which has declined. I'm sure the problem was just one of translation, but thought it worthwhile bringing it to your attention. (John Streicker, Yukon College)	See 15 - 981
15-982	A	27	2	27	4	Care needed with the use of words. Using "impacted" equates impact with negative impact, especially in the light of the following clause where it is not used to denote positive change. It is also unclear whether "protected arctic animal populations" refers to other ungulates, mammals or insects! (Philip Hill, Geological Survey of Canada)	"impacted" is correct in this context agreed, text modified
15-983	A	27	3			Chapter 15.4.2.3 Consequences of changes in ecosystem structure and function…; A reference to Aanes, Sæther and Ørietsland (2000) Fluctuations of an introduced population of Svalbard reindeer:The effects of density dependence and climatic variation. Ecography 23:437-443 should be included. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	Accepted – text modified
15-984	A	27	6			Comment on para. This should note whether the advance in treeline is unprecedented or not. See, e.g., [1] Esper, J and Schweingruber, FH. 2004. Large-scale treeline changes recorded in Siberia. Geophysical Research Letters 31: 10.1029/2003GL019178. [2] MacDonald GM, Velichko AA, Kremenetski CV, Borisova OK, Goleva AA, Andreev AA, Cwynar LC, Riding RT, Forman SL, Edwards TWD, Aravena R, Hammarlund D, Szeicz JM, Gattaulin VN. 2000.	Accepted – text modified

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						Holocene treeline history and climate change across northern Eurasia. QUATERNARY RESEARCH 53 (3): 302-311 MAY 2000 (Indur Goklany, Office of Policy Analysis, Department of the Interior)	
15-985	A	27	6	27	13	There have also been changes in peatlands and their vegetation related to permafrost degradation. Beilman and Robinson (2003) present some preliminary results which show that 10to 50% of original frozen peat plateaus have degraded (with associated changes in vegetation cover) over the last 50 years in the discontinuous permafrost zone in western Canada. Climate is the dominant trigger for the sites studied (ref: Beilman, D.W. and Robinson, S.D. 2003 Peatland permafrost that and landform type along a climate gradient. Permafrost - Proceedings of 8th Int. Conf. on Permafrost. M. Phillips, S.M. Springman and L. Arenson ed. p. 61-65.) (Sharon Smith, Geological Survey of Canada)	Accepted – text modified
15-986	A	27	7	27	7	specifiy Sewrad Peninsula or for all Alaskan tundra?? (Jerry Brown, International Permafrsot Association)	Accepted – text modified
15-987	A	27	7	27	8	The Lloyd et al study was on the Seward Peninsula, and they document a movement of around 10 km. Your sentence implies much more. Treeline "movements" are quite complex, they vary from region to region, so either review all the literature, or don't mention it. Or simply state that in thes one small area of the Seward Peninsula, this was found. (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-988	A	27	8	27	8	the response in northern Scandinavia is mainly due to the mid-century warming and landuse changes, with no or retreating response during last decades (ref: Dalen, L. & Hofgaard,A. 2005, Differential regional treeline dynamics in the Scandes Mountains. Arctic, Antarctic, and Alpine Research 37: 284-296) (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text modified
15-989	A	27	11	27	11	Do you mean permafrost degradation in the discontinuous zone (rather than discontinuous permafrost degradation) (Sharon Smith, Geological Survey of Canada)	Accepted – text modified
15-990	A	27	12	27	12	"in some areas permafrost". Should read "in some areas of permafrost" (Bruce Forbes, University of Lapland)	Accepted – text modified
15-991	A	27	12			„in some areas where permafrost has melted... (Robert Jefferies, University of Toronto)	Accepted – text modified
15-992	A	27	12	27	12	Delete "permafrost". (Peter Lemke, Alfred Wegener Institute)	Accepted – text modified
15-993	A	27	12			Change "some areas permafrost" to "some areas of permafrost". In addition to Smith et al., 2005 you might also cite Stow et al. 2004, which can be referenced as	Accepted – text modified

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						Stow, D., A. Hope, A.D. McGuire, D. Verbyla, J. Gamon, K. Huemmrich, S. Houston, C. Racine, M. Sturm, K. Tape, K. Yoshikawa, L. Hinzman, C. Tweedie, B. Noyle, C. Silapaswan, D. Douglas, B. Griffith, G. Jia, H. Epstein, D. Walker, S. Daeschner, A. Petersen, L. Zhou, and R. Myneni. 2004. Remote sensing of vegetation and land-cover changes in Arctic tundra ecosystems. Remote Sensing of Environment 89:281-308. (Anthony McGuire, University of Alaska Fairbanks)	
15-994	A	27	12			Word missing. (Hans Meltofte, National Environmental Research Institute)	Accepted – text modified
15-995	A	27	12			I would suggest: "… whereas arctic ponds are disappearing in some areas of discontinuous permafrost…" (Vladimir Romanovsky, University of Alaska Fairbanks)	Accepted – text modified
15-996	A	27	12			...some areas OF permafrost." (Laurence C. Smith, University of California, Los Angeles (UCLA))	Accepted – text modified
15-997	A	27	15	27	16	It would be more clear to say "(increasing at a rate of 3 days per decade)" and "(increasing at a rate of 1 day per decade)" (John Calder, National Oceanic and Atmospheric Administration)	Accepted – text modified
15-998	A	27	15			Suggest change "Satellite images show" to "Analyses of satellite images indicate" (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-999	A	27	16			higher (NOT warmer) water temperatures (Roger Barry, University of Colorado)	Cannot locate: no action
15-1000	A	27	16			In addition to Smith et al., 2004 b and McGuire et al. in press, I suggest citing Euskirchen et al. in press and McDonald et al. 2004, which can be referenced as McDonald KC, Kimball JS, Njoku E, Zimmermann R, Zhao M (2004) Variability in springtime thaw in the terrestrial high latitudes: monitoring a major control on the biospheric assimilation of atmospheric CO2 with spaceborne microwave remote sensing. Earth Interactions, 8, 1-23. (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1001	A	27	17	27	18	Delayed with respect to what? (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-1002	A	27	20			Section 15.4.2.2 This section provides no information on possible effects of changes in the active layer and permafrost (Vladimir Romanovsky, University of Alaska Fairbanks)	Accepted – text modified
15-1003	A	27	20	28	5	Missing: reference to the spruce bark beetle. It has killed 80% of stands of spruce in SW Yukon, SE Alaska. The beetle population is exploding as winters have not been severe enough to keep the pest in check. (John Streicker, Yukon College)	Accepted – text modified

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15-1004	A	27	22	27	23	The boreal forest is considered species-poor, in a biogeographic sense. (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-1005	A	27	22	27	34	Time scales are important here. How rapidly can forest replace tundra? (Philip Hill, Geological Survey of Canada)	Accepted – text modified
15-1006	A	27	22	27	38	Line 22 conflicts with line 38 (Larry Hinzman, University of Alaska Fairbanks)	Accepted – text modified
15-1007	A	27	22	27	22	This can be questioned as the boreal communities predicted to exchange present tundra are species poor communities (Annika Hofgaard, Norwegian Institute for Nature Research)	But they still have tree-dwelling birds and insects, and wood-decomposing microbes and invertebrates etc. : no action
15-1008	A	27	22	27	34	The text does not include mention of the potential problems caused by non-native invasive species being introduced into these terrestrial ecosystems. There is a major risk here. Also, it might be useful to mention migratory birds and mammals, whose patterns of migration are likely to be markedly changed. For birds, this might mean that more energy is expended on longer flights between Arctic breeding grounds and temperate over-wintering grounds. For mammals, the loss of tundra reduces summer grazing grounds and the greater flows in rivers, loss of permafrost, etc., might actually 'cut' their traditional migration pathways. (Michael Usher, University of Stirling)	Accepted – text modified
15-1009	A	27	23	27	26	This is confusing. (Gordon McBean, University of Western Ontario)	Accepted – text modified
15-1010	A	27	26	27	27	Better explain what is an "ecological cascade". (Konrad Gajewski, University of Ottawa)	Accepted – text modified
15-1011	A	27	34			Change "North American mink)" to "North American mink,"? (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1012	A	27	36	27	43	Most of the experiments behind these results do not control for the wind effect on the communities or species studied. The wind is mostly dramatically reduced or exluded due to the experimental design. Thus, the effect of warming per se is mostly unknown. This complicating fact should be mentioned, as wind is a dominating environmental factor in the Arctic. (Annika Hofgaard, Norwegian Institute for Nature Research)	I partly agree, but there is also validation of the approach: NO action as there is no space for detail
15-1013	A	27	38	27	38	The experimental results showing that species diversity decreased appears to contradict the opening statement of line 22. I think you are talking about different parts of the animal and plant kingdoms but I can't be sure. (Philip Hill, Geological Survey of Canada)	Accepted – text modified
15-1014	A	27	40	27	42	incomplete sentence (John Calder, National Oceanic and Atmospheric Administration)	Accepted – text modified
15-	A	27	40	27	42	Words missing.	Accepted – text modified

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1015						(Hans Meltofte, National Environmental Research Institute)	
15-1016	A	27	42	27	43	According to studies at Zackenberg a) Ambient UV-B radiation decreases net photosynthesis in high arctic Vaccinium uliginosum (reference 1); b) Reduced ambient UV- radiation increases Fv/Fm in Salix arctica and Vaccinium uliginosum and reduces stomatal conductance and internal CO2 concentration in Salix arctica (reference 2); c) Ambient UV-B radiation decreases the photosynthetic performance and has negative impacts on the photosynthetic machinery in high arctic Salix arctica (reference 3); d) Ambient UV-radiation changes microbial community composition and structure in a high arctic heath (reference 4); and e) Ambient UV-radiation decreases the maximal quantum yield (Fv/Fm) in Salix arctica and Vaccinium uliginosum during three years in high arctic (reference 5). Maybe some of this is of interest to you. 1) Albert K.R., Ro-Poulsen H. & Mikkelsen T.N. submitted. Ambient UV-B radiation decreases photosynthesis and has negative effects on chlorophyll-a fluorescence parameters in Vaccinium uliginosum canopy in the high arctic. 2) Bredahl L., Ro-Poulsen H. & Mikkelsen T.N. 2004. Reduction of the Ambient UV-B Radiation in the High Arctic increases Fv/Fm in Salix arctica and Vaccinium uliginosum and reduces Stomatal Conductance and internal CO2 Concentration in Salix arctica. - Arctic, Antarctic and Alpine Research 36: 363-369. 3) Albert K.R., Mikkelsen T.N. & Ro-Poulsen H. 2005. Effects of ambient versus reduced UV-B radition on high arctic Salix arctica assesed by measurements and calculations of chlorophyll-a fluorescence parameters from fluorescence transients. - Physiologia Plantarum. 124: 208-226. 4) Albert K.R., Ro-Poulsen H., Mikkelsen T.N., Håkansson K.B., Bredahl L. in prep.: Ambient UV-radiation increases plant stress by decreases in Fv/Fm and Performance indexes, despite increase in UV-absorbing compounds in High Arctic Salix arctica and Vaccinium uliginosum during a three year UV-exclusion experiment. (Hans Meltofte, National Environmental Research Institute)	Partly accepted – text modified to include the more *important* responses of plants to UV-B – see point 15-1016 below
15-1017	A	27	42	27	43	5) Rinnan R., Keinanen M.M., Kasurinen A., Kasikainen J., Kekki T.K., Holopainen T., Ro-Poulsen H., Mikkelsen T.N. and Michelsen A. 2005. Ambient UV radiation in the Arctic reduces root biomass and alters microbial community composition but has no effects on microbial biomass. Global Change Biology 11(4): 564-574. (Hans Meltofte, National Environmental Research Institute)	Accepted – text modified
15-1018	A	27	45	27	50	are these models consistent with page 11 diagrams. Why not use same references?? (Jerry Brown, International Permafrsot Association)	Accepted – text modified

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15-1019	A	27	45	27	46	"Models project replacement of 11% to 50% of tundra by forest by 2100, although impacts of changing land use, hydrology and permafrost are excluded". Despite this exclusion from the models, it is still worth mentioning that land use and anthropogenic disturbance have documented effects on ground cover and that - once established - graminoid-dominated vegetation types can persist for decades, if not centuries (Forbes et al. 2001; Nellemann et al. 2001; Vlassova 2002). References: Nellemann, C. and 15 others (2001) GLOBIO Global methodology for mapping human impacts on the biosphere: the Arctic 2050 scenario and global application. UNEP/DEWA Technical Report 3, 47 pp.; Forbes, B.C., J.J. Ebersole and B. Strandberg (2001) Anthropogenic disturbance and patch dynamics in circumpolar arctic ecosystems. Conservation Biology 15:954-969; Vlassova, T. K. (2002). Human impacts on the tundra-taiga zone dynamics: The case of the Russian lesotundra. Ambio Special Report 12: 30-36. (Bruce Forbes, University of Lapland)	Accepted – text modified, but most detail cannot be included
15-1020	A	27	45	28	2	It should be pointed out that this is very hypotethical due to current simplicity of used models (Annika Hofgaard, Norwegian Institute for Nature Research)	No action: the point is already made
15-1021	A	27	46	27	46	Yes, but without these impact factors the model outputs will not be realistic projections. (Annika Hofgaard, Norwegian Institute for Nature Research)	See 15 - 1020
15-1022	A	28	4	28	5	This section should be expanded (Annika Hofgaard, Norwegian Institute for Nature Research)	Accepted – text inserted
15-1023	A	28	4	28	5	This paragraph seemed too short, particularly when there are also examples of pests – e.g. outbreaks of spruce bark beetle (Dendroctonus rufipennis) in Yukon (Krebs, C.J., Boonstra, R., Boutin, S. & Sinclair, A.R.E. 2001. Conclusions and future directions. In Ecosystem Dynamics and the Boreal Forest, ed. By C.J. Krebs, S. Boutin & R. Boonstra. Oxford University Press. Pp. 492-501.) and defoliation of downy birch (Betula pubescens) in Arctic Finland by the larvae of the autumn moth (Epirrita autumnata) (Usher, 2005 – already cited). (Michael Usher, University of Stirling)	Accepted – see comment 15-1022 above
15-1024	A	28	7	29	1	Again, should this be in this chapter? (Philip Hill, Geological Survey of Canada)	Yes: WG I deal with forcing, WG II with processes
15-1025	A	28	7			Section 15.4.2.3 This section provides almost no information on possible effects of changes in the active layer and permafrost (Vladimir Romanovsky, University of Alaska Fairbanks)	Accepted – text modified
15-1026	A	28	10	26	11	Alaska studies of coastal erosion: Lestak L. R., Manley W. F., and Maslanik J. A., 2004: Photogrammetric analysis of coastal erosion along the Chukchi Coast at	Do not understand why these comments are here: No action

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						Barrow, Alaska. Arctic Coastal Dynamics, Report of an International Workshop. Berichte zur Polar and Meeresforschung (in pre (Roger Barry, University of Colorado)	
15-1027	A	28	10	28	50	Climate warmimg could make some permafrost peatland sites, but not all northern peatlands which are patterned and ecologically uneven. The case examples given in this paragraph should be presented not as predicting scenario but as a possible option demonstrating complexity of the problem with potential serious feedback to GHG emissions.(see Ch. 1. page 21. lines 45-48). (Andrey Sirin, Institute of Forest Science Russian Academy of Sciences)	Complexity is already covered: no action
15-1028	A	28	15			It would be good to have a reference for "Measurements suggest the Arctic is a small carbon source". I'm guest editor of an invited feature of Ecological Applications that is supposed to contain this paper, but I haven't received a copy of it yet. (Anthony McGuire, University of Alaska Fairbanks)	Accepted – reference added
15-1029	A	28	15	28	22	Is drainage not an important factor in determining whether CO2 or methane will be released and whether the tundra will be a source or sink as permafrost degrades? (Sharon Smith, Geological Survey of Canada)	This is covered in the following paragraph: No action
15-1030	A	28	16			Change "with a large standard deviation of about 40 g C m-2 yr-1)" to "with a large spatial variance (standard deviation of 40 g C m-2 yr-1)" (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1031	A	28	17			In addition to Sitch et al. 2003, also cite Sitch et al. in press. (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1032	A	28	20			The Christensen et al., in prep paper is the paper I've been waiting for as guest editor of Ecological Applications. I'm guessing it needs to be removed. One could cite Sitch et al. in press as well as Zhuang et al. in press. (Anthony McGuire, University of Alaska Fairbanks)	Accepted – appropriate action taken
15-1033	A	28	24	28	24	"northward movement of productive vegetation". This assumption may not be vaIid in heavily disturbed portions of the forest-tundra, particularly in northern Russia, where the treeline has actually retreated southward in areas of heavy industrial and other disturbance, such as West Siberia (see above point, and Vlassova 2002). (Bruce Forbes, University of Lapland)	Accepted – text modified
15-1034	A	28	24	28	36	I think that content of 15.4.2.3 sub-section can be based on more available publications and can include results of numerical estimations of Arctic and sub-arctic ecosystem carbon sources and sinks, for instance: Aurela, M., T. Laurila, and J.-P. Touvinen, 2001 Seasonal CO2 balances of a subarctic mire. Journal of Geophysical Res. V. 106., D2, pp. 1623-1637; Turunen, J. et al., 2002: Holocene, 12, 79-90.; Welker, J.M. et al., 2000: Climatic Change 44, 139-150.	Appropriate references are already given and some of these refer to the reviewer's suggestions (we have little space): No action

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						(Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	
15-1035	A	28	25			Comma not semicolon. (Roger Barry, University of Colorado)	Cannot find the problem: no action
15-1036	A	28	32	28	35	Needs to be rewritten to be clear. (Gordon McBean, University of Western Ontario)	Anisimov to fix
15-1037	A	28	33	28	34	The 80 % “project methane emission” increase sounds overestimated (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Anisimov to answer
15-1038	A	28	40			In addition to Sitch et al. 2003, also cite Sitch et al. in press. and Euskirchen et al. in press. (Anthony McGuire, University of Alaska Fairbanks)	Sitch et al., added but we cannot cover all “in press” articles
15-1039	A	28	44			Change "will" to "are projected to". (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1040	A	28	46	30	43	See comment #27. Particularly, reduce the political overtones of lines 35-43. (Philip Hill, Geological Survey of Canada)	We do not understand the concerns
15-1041	A	28	48			Change "eastern Canadian arctic forest" to "central Canadian boreal forests". (Anthony McGuire, University of Alaska Fairbanks)	Accepted – text modified
15-1042	A	29	3			Section 15.4.2.4 This section provides no information on possible effects of changes in the active layer and permafrost (Vladimir Romanovsky, University of Alaska Fairbanks)	
15-1043	A	29	5	29	27	This paragraph is mainly statement of the present and impacts are only mentioned in the last paragraph. Too much stage-setting and not enough concrete statements about impacts. (Philip Hill, Geological Survey of Canada)	
15-1044	A	29	5	29	7	Non-traditional activities are much more significant in economic terms. The Nordic countries in particular are modern societies with market economies. Traditional fishing, for instance, does barely exist. (Alf Håkon Hoel, University of Tromsø)	CF-Accepted – but is there data on this ? AHDR Economics Chapter ?
15-1045	A	29	7			Chapter 15.4.2.4 Impacts on resource use, … The correct reference to the AMAP scientific report (AMAP assessment: POPs 2002) is not 2003 but 2004! The correct reference to the AMAP Human Health Report (AMAP assessment 2002: Human Health in the Arctic) is 2003! The reference to AMAP 2003 is included several places in the chapter! (Geir Wing Gabrielsen, The Norwegian Polar Institute)	CF-To verify referencing
15-1046	A	29	8			convert to g/day so it may be compared to other numbers reported in this paragraph (Larry Hinzman, University of Alaska Fairbanks)	CF-accepted, edited to g/day

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15-1047	A	29	8	29	22	There is way to much detail (relevant to other subject) about the amount of wild food consumed. One sentence stating something like "Wild foods threatened by warming comprise a substantial portion of native diet." Would be sufficient. (Ian Joughin, Applied physics Lab, University of Washington)	CF-some detail is required to provide example. Accepted to be reduced.
15-1048	A	29	8	29	10	Consistent units should be used. (Gordon McBean, University of Western Ontario)	CF-accepted, edited to g/day.
15-1049	A	29	10	29	11	Please see Pars, T., Osler, M. & Bjerregaard, P. 2001. Contemporary use of traditional and imported food among Greenlandic inuit. Arctic 54: 22-31. (Hans Meltofte, National Environmental Research Institute)	CF-Can't provide examples in each country. AMAP reference is best reference with data from this and other papers.
15-1050	A	29	14	29	17	Caribou are very important but not enough to be mentioned in section 15.4.2.2? (Philip Hill, Geological Survey of Canada)	TVC Reindeer are specifically mentioned in15.4.2.1 (page 26, lines 41 and 48), and section 15.4.2.2 (Page 28 line 5). We have no more space to go into further detail.
15-1051	A	29	17	29	19	The comparison is not valid. (Gordon McBean, University of Western Ontario)	CF-edited, not intended as comparison but description of variety of values and roles of resources for food and economies.
15-1052	A	29	21	29	21	I believe "Klopov" should read Klokov. (Bruce Forbes, University of Lapland)	CF-to verify
15-1053	A	29	29	33	35	This sentence is not clear. Please rewrite. (Marybeth Long Martello, Harvard University)	
15-1054	A	29	29	3	27	This paragraph describes reliance on wild foods, but does not make a direct connection between projected climate-related trends and potential impacts. The last sentence refers to changes in hunting conditions, but does not specify what the key changes are. Paragraph would be stronger if such changes were listed briefly and early in the paragraph. Or paragraph should refer reader back to sections that detail relevant changes. (Marybeth Long Martello, Harvard University)	CF-to consider
15-1055	A	29	29	31	31	Change "agricultural" to "agriculture" (Marybeth Long Martello, Harvard University)	CF-already done ?
15-1056	A	29	31			This is the ACIA report (Gordon McBean, University of Western Ontario)	CF-Juday et al., is more recent from ACIA
15-1057	A	29	33			incomplete sentence (John Calder, National Oceanic and Atmospheric Administration)	TVC suggests "By mid-21st Century, climatic warming may displace the position of this limit to the north by …."
15-1058	A	29	33			warming may 'see' displacement (Peter Johnson, University of Ottawa)	CF-correct
15-	A	29	33	29	34	…. warming may lead to a displacement ….. by a few hundred kilometres …...	CF-correct

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1059						(Peter Lemke, Alfred Wegener Institute)	
15-1060	A	29	33	29	34	Words missing. (Hans Meltofte, National Environmental Research Institute)	CF-correct
15-1061	A	29	42			To have a section 15.4.3 with 4 sub-sections matching the four in the freshwater and terrestrial sections would be helpful, allowing for the effects of climate change in all 3 biomes to be compared. This would necessitate drafting a piece on the effects of climate change on biodiversity; I suspect that this could be lifted from chapters 9 and/or 10 in the ACIA (Michael Usher, University of Stirling)	The section has been rewritten and hopefully is now easier to understand/follow
15-1062	A	29	42	33	39	found the marine section's structure rather difficult to follow. It would be much better if it could be structured like the freshwater and terrestrial sections in 15.4.1 and 15.4.2. At the moment we have a 15.4.3 which immediately becomes 15.4.3.1 (and no .2, .3, etc.), a 15.4.4 which is in fact a 'box', and then a 15.4.5 which addresses services provided by marine ecosystems in the Antarctic (see next comment) (Michael Usher, University of Stirling)	See above
15-1063	A	29	47	29	49	Given the histories given in the cod box example, this seems like a sweeping statement. Needs justification. (Philip Hill, Geological Survey of Canada)	ACIA; Loeng et al.
15-1064	A	30	1			Mega Deltas ? define (Roger Barry, University of Colorado)	Misunderstanding (listing incorrect?)
15-1065	A	30	1	30	2	Here you refer to "consequences" for polar bears but fail to describe the consequences. The ACIA goes so far as to say these species will be pushed towards extinction. Direct habitat loss will mean a corresponding decline in the species. (John Streicker, Yukon College)	Inserted. However, the present author thinks this is a pretty strong statement in ACIA. At any rate many other species will go the same way.
15-1066	A	30	3	30	5	Chapter 15.4.3.1 Changes in a warming climate: A reference to AMAP Pathway report (2003) (AMAP Assessment 2002: The influence of Global Change on Contaminant Pathway to, within and from the Arctic) should be given! (Geir Wing Gabrielsen, The Norwegian Polar Institute)	Agree, will be given.
15-1067	A	30	3	30	3	It is likely …. (Peter Lemke, Alfred Wegener Institute)	Changed
15-1068	A	30	11	30	33	This paragraph could be reduced in size without information loss (Robert Jefferies, University of Toronto)	This paragraph has been rehashed and shortened
15-1069	A	30	20			In what sense is commercial exploitation a "multiple stress"? I don't understand what is meant here. (Martin Sharp, University of Alberta)	Removed, but one would get different stresses from different gear (e.g. passive versus dragged
15-	A	30	26			Hamilton, L.C., Brown, B.C., and Rasmussen, R.O.: 2003, 'West Greenland's Cod-	Good point. We are aware of this but cannot

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1070						to-Shrimp Transition: Local Dimensions of Climatic Change', Arctic 56(3), 271–282. (Larry Hinzman, University of Alaska Fairbanks)	do much within the within the space limit.
15-1071	A	30	27	30	31	It would be worthwhile to mention that changes in the migrations of fish, or displacements of their habitats, may upset existing sharing agreements on stocks that are found with the exclusive economic zones (EEZ) of two or more states, or in the open ocean outside the EEZs. A famous case is the breakdown in the salmon agreement between Canada and the United States, apparently as a result of a change in the climate regime in the North Pacific. One source on this is Miller, K.A. and G.R. Munro (2004): Climate and Cooperation: A New Perspective on the Management of Shared Fish Stock. Marine Resource Economics 19:367-394. (Rognvaldur Hannesson, Norwegian School of Economics and Business Administration)	Good point. This is obvious and inferred in the text. As a matter of fact it is one of the major problems in modern fisheries management.
15-1072	A	30	30	3	3	Insert "is" after "it" (Marybeth Long Martello, Harvard University)	Noted
15-1073	A	30	32			How important is it to maintain spawning stock levels to ensure recruitment? I don't think anyone has been able to demonstrate a clear relationship between recruitment and spawning stock. The sentence talks about environmental variability, but climate change is variability of a special kind, namely with a rising trend in temperature. If some stocks are doomed within their traditional habitats because of this warming, what is the point of trying to protect recruitment? (Rognvaldur Hannesson, Norwegian School of Economics and Business Administration)	The text has been changed so this is no longer an issue. However, it is a misunderstanding that no one has demonstrated a stock/recruitment relationship. The message here is that for some stocks (e.g. cod) large year classes seem to become a chance occurrence below a certain SSB size, most likely due to lack of year classes, including older fish, in the spawning stock. Naturally, if a stock is doomed in its previous geographic area there is no use trying to maintaining an SSB level.
15-1074	A	30	35			This says, "the required knowledge base is growing rapidly". What is probably should say is "the knowledge base is growing rapidly" (Larry Hinzman, University of Alaska Fairbanks)	Agree
15-1075	A	30	38	30	38	"…great deal at SKATE…" (David E Atkinson, University of Alaska Fairbanks)	Done
15-1076	A	30	38			replace "skate" with "stake" (John Calder, National Oceanic and Atmospheric Administration)	Done
15-	A	30	38			"because there is a great deal at skate." stake?? Either way, this statement is	No longer in text

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1077						somewhat colloquial for this discussion. (Larry Hinzman, University of Alaska Fairbanks)	
15-1078	A	30	38			stake' not 'skate' (Peter Johnson, University of Ottawa)	Done
15-1079	A	30	38			Skate should be stake. (Lloyd Peck, British Antarctic Survey)	Done
15-1080	A	30	38			should be "stake," not "skate" (Laurence C. Smith, University of California, Los Angeles (UCLA))	Done
15-1081	A	30	46	32	32	I suppose the information in the box is useful to illustrate the many different factors affecting fisheries, although the climte connection does not seem very strong (Gunter Weller, University of Alaska)	There is a very strong connection between climate and cod at W-Greenland and the drift of juvenile cod from Iceland over there. The fishery aspect is interesting in the sense that it may interfere with the ability of Nature to react to climate change in a 'logical' way. The 'northern cod' episode is interesting for demonstrating how climate change may amplify and interact with other stresses on fish stocks, causing changes in survival rates, distribution and abundance. This stock lives at the extreme lower temperature range for cod and yet could be fished 'in moderation' for centuries without any obvious effects on abundance. Then fishing pressure accelerates skywards in a cold period and everything goes haywire – no cod any more. This can be compared to the situation at Iceland and in the Barents Sea where conditions are milder – and there is still cod in spite of a fishing mortality that is too high.
15-1082	A	30	47			I am not convinced that all of the details provided in box 15.4.4 is necessary. I think it would be possible to reduse this example by 25% without serious injury. (Larry Hinzman, University of Alaska Fairbanks)	The box has been reduced somewhat. See also Gunter weller above.
15-1083	A	31	49	32	32	It's not clear to me that this second example (from a sub-polar region) is necessary. It's a lsesson in fisheries management but does not add much to the debate on climate change impacts that the Greenland/Iceland example has not already said. (Philip Hill, Geological Survey of Canada)	See second above (Gunter Weller)
15-	A	31	49	31	32	I am not convinced that this should be included as mostly it is a consequence of	See third above (Gunter Weller). Also,

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1084						overfishing and lack of adequate models and political will. (Robert Jefferies, University of Toronto)	overfishing a stock at the very extreme of its distribution is quite different from overfishing at an extreme distribution range. Ay Iceland and in the Barents Sea all one has to do is to reduce the F by half for say 5-10 years to get the stocks up and increase production by at least 50%. However, nobody is willing to 'hang the bill on the cat' so to say. I believe we have an example of the opposire in the 'northern cod'
15-1085	A	31	49	32	32	It would be appropriate to add to this highlight on the Newfoundland/Labrador northern cod a reference to the following book: Arms, M., 2004: Servants of the Fish: A Portrait of Newfoundland after the Great Cod Collapse, Upper Access, Inc., Hinesburg, VT, 243 pp. This book is centered on the northern cod changes and the impact that these changes have had on the people and economy of Newfoundland. (Claire Parkinson, NASA Goddard Space Flight Center)	Thanks for pointing this out. But for the same reasons as for Greenland, namely space restrictions, we have to leave this out.
15-1086	A	32	0			Chapter 15.4.5 Marine ecosystems… I would have liked to see more information presented about the krill resources (estimate and population status/development) in the Antarctic ecosystem (Geir Wing Gabrielsen, The Norwegian Polar Institute)	
15-1087	A	32	6	32	6	In what year was the EEZ extended? This gives a feel for the rate of decline. (David E Atkinson, University of Alaska Fairbanks)	
15-1088	A	32	6			In which year did Canada extend its EEZ to 200 miles? (Gordon McBean, University of Western Ontario)	
15-1089	A	32	19			Peck's work suggests that, certainly for some invertebrates, chronic exposure to temperatures as little as 2-4ºC above their current norms may be sufficient to compromise body function. (Peter Convey, British Antarctic Survey)	Comment misplaced?
15-1090	A	32	22	32	22	"…increased mortalities of their PRAY…" (David E Atkinson, University of Alaska Fairbanks)	Accepted
15-1091	A	32	36			given extensive reference to the work of CCAMLR, should there also be reference to the (considerably more ineffectual and politically influenced) work of the IWC here with reference to whale stocks, and their influence within the marine food web? If so, there should also be recognition that there is no automatic logic leading to ecosystem recovery to an "original state" even with whale conservation measures; indeed, it would appear that the much more rapid recovery ability of fur seals in the Antarctic may have led to a permanent shift in the marine food web	No space available for expansion

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						structure. (Peter Convey, British Antarctic Survey)	
15-1092	A	32	36	33	39	The Antarctic seems to have been missed from much of this chapter, and hence I welcome this piece. However, it would be useful again to expand this so that the four sections mentioned above can each be addressed. (Michael Usher, University of Stirling)	No space available for expansion
15-1093	A	32	43	32	44	CCAMLR defined again (already done so on p9 ln 40-41) (David E Atkinson, University of Alaska Fairbanks)	
15-1094	A	32	43	32	46	It is stated that CCAMLR tries to maintain the natural ecosystem while allowing sustainable exploitation. What does this mean? Exploitation always means a disturbance of an ecosystem, we cannot both preserve the fish and catch it too. (Rognvaldur Hannesson, Norwegian School of Economics and Business Administration)	DGV – I think the spirit of the meaning is clear
15-1095	A	32	50			there is also a considerable Southern Ocean fishery for squid, which merits mention. (Peter Convey, British Antarctic Survey)	Will consider
15-1096	A	33	0			Chapter 15.4.6 Human Health and well being There are several reports (AMAP, ACIA etc.) which deal with the impact of climate and pollution and impacts on humans. Some informations and references should be presented in the IPCC report. (Geir Wing Gabrielsen, The Norwegian Polar Institute)	Not considered in the scope of IPCC
15-1097	A	33	7	33	9	Words or sentence missing. (Hans Meltofte, National Environmental Research Institute)	noted
15-1098	A	33	7	33	9	The sentence needs to be completed by adding what happened to over 50% of the krill stock. (Claire Parkinson, NASA Goddard Space Flight Center)	Noted
15-1099	A	33	7	33	9	Sentence does not make sense. (Lloyd Peck, British Antarctic Survey)	Noted
15-1100	A	33	7	33	9	Insufficient sentence (Jan-Gunnar Winther, Norwegian Polar Institute)	Noted
15-1101	A	33	8	33	9	unfinished sesntence (Peter Johnson, University of Ottawa)	Noted
15-1102	A	33	15	33	22	Antarctic poikilotherms are much more sensitive to temperature change than this. Several Antarctic marine cold-blooded species have been shown to be sensitive to warming of as little as 2-3°C (Peck et al 2004, Functional Ecology). There is need to add a small section here on the work of Portner at the Alfred Wegener Institute showing the mechanism for the extreme sensitivity of Antarctic marine species to a warming environment.	Noted

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						(Lloyd Peck, British Antarctic Survey)	
15-1103	A	33	16	33	18	And this level of certainty is based on what? (Philip Hill, Geological Survey of Canada)	?
15-1104	A	33	24			delete one 'ecosystems' (Peter Johnson, University of Ottawa)	Noted
15-1105	A	33	24	33	25	Wording wrong. (Hans Meltofte, National Environmental Research Institute)	Noted
15-1106	A	33	27			ocean circulation patterns' not 'pattern ocean circulation' (Peter Johnson, University of Ottawa)	Noted
15-1107	A	33	27			Word missing. (Hans Meltofte, National Environmental Research Institute)	Noted
15-1108	A	33	33	27	27	Move "patterns" to after "ocean circulation" (Marybeth Long Martello, Harvard University)	Noted
15-1109	A	33	33	42	47	How is well-being defined? For example, does this chapter address well-being as addressed in the Arctic Human Development Report? Well-being is a concept with a long history in scholarly and grey literatures. How does it's treatment in this chapter relate to those literatures? (Marybeth Long Martello, Harvard University)	Not sure how to respond to this without a long definition of what is essentially a all-encompassing concept
15-1110	A	33	33	24	24	Delete the first "ecosystems" (Marybeth Long Martello, Harvard University)	Noted
15-1111	A	33	37			Comment on para. This seems like an endorsement for the CCAMLR. This seems more like a political statement that doesn't belong in a scientific and technical report such as the IPCC's AR4. Moreover, before any such endorsement is made, there should be, as a start, an analysis of the issue and a weighing of the various pros and cons. I think it would be better to replace the current para with the following: "Longer duration an more spatially extensive monitoring data are required to help identify change, its effects and their management." (Indur Goklany, Office of Policy Analysis, Department of the Interior)	# The point that a “precautionary” principle lies at the heart of CCAMLR is an important one to make although it does need to be made without seeming endorsement. Therefore the text will be modified
15-1112	A	33	42			Section 15.4.6: How is well-being defined? For example, does this chapter address well-being as addressed in the Arctic Human Development Report and/or the Millennium Ecosystem Assessment? Well-being is a concept with a long history in scholarly and grey literatures. How does it's treatment in this chapter relate to those literatures? If the report on the whole does not address these questions, then this chapter should, at least briefly address them. (Marybeth Long Martello, Harvard University)	CF-Health here is defined and used in the broad sense, as in WHO, 1968; Well-being is used as is in the literature, but limited by space to discuss ALL aspects of well-being. Inclusion here of aspects of lifestyle, culture and language are considered, other sections discuss non-medical determinants of health, but space is limited on health and well-being

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							to consider all factors. As well, studies on connection between climate and climate change and these factors are few to date
15-1113	A	33	42	36	36	It's understandable that this section on human health and well-being concentrates on the Arctic. However, there are people in the Antarctic also and so there should be at least something said about the Antarctic as well. (Claire Parkinson, NASA Goddard Space Flight Center)	On a global scale the numbers of people effected are small, and #DGV
15-1114	A	33	49	34	26	It is unclear why UV-B radiation is included in a discussion of climate change. It does not appear in any of the earlier chapters, including Chapter 8 on human health. References to UV-B should be deleted. If they are retained, an explanation for their inclusion needs to be added. Also, the Montreal Protocol TEAP projections of decreases in ozone depleting chemicals and recovery of the ozone layer need to be included to indicate that this problem will be disappearing on the same time scale as the impacts of climate change will be increasing. (Lenny Bernstein, IPIECA)	# We believe that we're justificed in not including an in-depth discussion of UV impacts, but we think that is important to note that UV is an additional, and additive stressor that complicates the response to CC. TVC: this is a general editorial comment
15-1115	A	34	1	34	26	Comment on paras 1 and 3 on this page. Should note that UVB should in the futurer recover. In other words, there should be less UVB radiation in the future than there is now (due to the Montrael Protocol). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-UV INCLUSION OR NOT ???
15-1116	A	34	1	36	36	This is a listing of effects. I suggest that a Table is prepared in which much of the information could appear linked to a short overview of the effects (Robert Jefferies, University of Toronto)	CF-to consider for shortening
15-1117	A	34	3	34	4	What is meant here - changes in precipitation amount, seasonality, intensity….? There is a need to be specific to make this statement useful (Martin Sharp, University of Alberta)	CF-intended meaning is "increases", accepted to edit
15-1118	A	34	4	34	10	This could be another area for cutting. These sorts of impacts represent fringe effects; I think of far greater importance are increased contaminants load and even stress due to changing lifestyles (OK I see this is specifically treated later on). Perhaps it could suffice to make a comment to the effect that varoius secondary effects due to alteration in weather patterns/effects are occurring, without going into specifics. THe references could be retained in an "e.g., see these reference" type of approch. (David E Atkinson, University of Alaska Fairbanks)	CF-TO CHECK WAYS OF CUTTING AND REFER TO NEW PAPERS
15-1119	A	34	6	34	20	Reading through these sentences, I had a sense that there was a conflict in what was being found--and some seemed quite surprising. If there is an increase in non-fatal infarctions with temperature, would not one expect that those in low latitudes would be long gone? What is causing this--is it clear it is temperature, or might it	CF-it is a behavioural adaptation issue in combination with climate or environmental change. CF to verify.

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						be the seasonal range of temperature, or changes in lifestyles given the changes in climate, etc.--it just seems a bit strange. Is the correlation with the AO a result of the conditions that result or something else? (Michael MacCracken, Climate Institute)	
15-1120	A	34	8	34	8	Is that "strong correlation" positive, and is it strong in all seasons? The Arctic Oscillation and the North Atlantic Oscillation are most pronounced in winter. (Peter Lemke, Alfred Wegener Institute)	CF-to verify in Messner article
15-1121	A	34	9			associated 'with' extreme (Peter Johnson, University of Ottawa)	CF-accepted
15-1122	A	34	16			Should indicate what is the excess annual moratality death (typically) due to extreme heat. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-to consider, limited by space
15-1123	A	34	17	34	17	What evidence? (Philip Hill, Geological Survey of Canada)	CF-Evidence shown above in previous paragraph.
15-1124	A	34	20			here and following - reference to a publication in review. (Gordon McBean, University of Western Ontario)	CF-NOW PUBLISHED
15-1125	A	34	22	34	24	How the immune system is affected needs a bit of explanation. It ought to be explained that there is both more UV coming down and with warming people will be out more, so exposure can go up sharply. (Michael MacCracken, Climate Institute)	CF-to cut references to UV
15-1126	A	34	28	34	28	In the heading, it would be clearer if it said "climate on the health of arctic residents" as it is not really clear that "arctic health applies to people. (Michael MacCracken, Climate Institute)	CF-to consider
15-1127	A	34	31	34	35	Given that it was about as warm in the 1920s and 1930s as it seems to be today, how doe this compare with prior experiences. Also how did populations mange these risks previously? experience (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-LITTLE DATA IN SOME CASES. Some discussion of previous experience appears earlier in chapter (socio-ecological resilience and current challenges to some adaptive strategies because of social and other change
15-1128	A	34	35	34	21	Section 15.4.6.2 Indirect… : This section repeats many points made earlier in the text. In particular the paragraph beginning at 35-21 begins talks about the wild foods again, the paragraph beginning at 35-31 goes on about external influences that have already been discussed and much of which is not a direct impact of climate change (Ian Joughin, Applied physics Lab, University of Washington)	CF-TO CHECK REDUNDANCY
15-1129	A	34	37	35	4	Again, perhaps the number of examples could be reduced in the interest of overall space - keep references, however. (David E Atkinson, University of Alaska Fairbanks)	CF-agreed, to edit

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15-1130	A	34	37			Comment on para. "It is likely" on line 40 and "will: on line 41 oversells how much we know about this matter. Socioeconomic factors, e.g., wealth, technological change, public health systems, etc., will probably be a greater factor in determining whether or not these will, indeed result in public health probems. See Goklany (2005b). (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-Not the incidence of zoonotic diseases in wildlife populations, no, but outbreaks in human populations related to public health intervention, or lack of, yes. Will edit to reflect this aspect.
15-1131	A	34	37	34	37	Make this clearer by saying "Climate warming in the Arctic during" (Michael MacCracken, Climate Institute)	CF-accepted to edit
15-1132	A	34	40	34	42	It would be clearer if replaced "these species which" with "those diseases that". But in midlatitudes, the incidence of such diseases peaks in winter due to people being relatively closely confined, etc., so warming allows people to separate more, etc. Will it really get enough warmer in the Arctic that the increase in disease vector survival will exceed the change in close contact of individuals? (Michael MacCracken, Climate Institute)	CF-agreed to edit. CF-don't know if warming will be enough to such that disease vector survival will exceed change in close contact. Currently no studies to support this specifically.
15-1133	A	34	44			Add Greenland ice sheet melt ; 2005 record; see http://cires.colorado.edu/science/groups/steffen/greenland/melt2005/: Steffen, K., S.V. Nghiem, R. Huff, and G. Neumann 2004. The melt anomaly of 2002 on the Greenland Ice Sheet from active and passive microwave satellite observations, Geophys. Res. Lett., 31(20), L2040210.1029/2004GL020444.. Hanna,H., P.Huybrechts, I. Janssens, J..Cappelen, K. Steffen, and A. Stephens 2005. Runoff and mass balance of the Greenland ice sheet: 1958–2003, J. Geophys. Res., 110, D13108, doi:10.1029/2004JD005641. (Roger Barry, University of Colorado)	CF-OK
15-1134	A	35	22			edit (John Calder, National Oceanic and Atmospheric Administration)	CF-accepted
15-1135	A	35	22	35	22	"contribute significant a proportion" should read 'contribute a significant proportion' (Bruce Forbes, University of Lapland)	CF-accepted to edit
15-1136	A	35	22			'a significant proportion' not 'significant a proportion' (Peter Johnson, University of Ottawa)	CF-to edit.
15-1137	A	35	25	35	29	Despite being listed as a key finding on page 4, this the only reference I can find to the release of contaminants such as mercury, the concentrations of these in some marine fish and mammals are high and as much of a danger to human health as the other issues studied, and with a correlation possibly existing betweeh open water and mercury fluxes from the ocean to atmosphere this is an issue that is only going to develop if predicted sea ice losses are realised (e.g. St Louis et al, 2005, Environ Sci Technol); also reference could be made to the increase in pollution associated	CF-to edit on pg 4, is not a key finding. Comparative risk evaluation of climate Vs contaminants is not possible to make with the current data. Risk to human health is (as documented in Nunavik) at current levels, subtle and possibly transitory. CF to edit to consider this comment and potential increase

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						with increased industry and economical development (Fiona Cawkwell, University of Alberta)	of local sources of pollution from industry and ec dev.
15-1138	A	35	31	35	33	Should note that despite these problems, their life expectancies have increased (Indur Goklany, Office of Policy Analysis, Department of the Interior)	CF-accepted, primarily due to health services though and not these current shifts which is associated with an increase in disease not previously seen in many northern populations
15-1139	A	35	31	35	42	The climate change impact thread is lost in this paragraph. (Philip Hill, Geological Survey of Canada)	CF-to restate, and put climate in context of other key drivers of health and well-being
15-1140	A	35	31	35	42	This paragraph includes some repetition. (Gordon McBean, University of Western Ontario)	CF-to edit
15-1141	A	35	31	35	42	This could be shorter. (Sharon Smith, Geological Survey of Canada)	CF-agreed, to shorten
15-1142	A	35	35	44	47	This is not a sentence. (Marybeth Long Martello, Harvard University)	CF-accepted
15-1143	A	35	35	31	35	These two sentences should be rewritten. (Marybeth Long Martello, Harvard University)	CF-accepted
15-1144	A	35	35	31	42	Less reliance on wild foods and the hunting, herding and gathering practices they entail can also mean loss of traditional knowledges important in carrying out these activities. (Marybeth Long Martello, Harvard University)	CF-as mentioned in TK section and vulnerability section of the chapter already
15-1145	A	35	38			suggest replacing "marks them off" with another phrase, such as "distinguishes them" (John Calder, National Oceanic and Atmospheric Administration)	CF-to edit
15-1146	A	36	2	36	12	Permafrost thawing may compromise the integrity of waste containment structures (eg. sewage lagoons, tailings ponds) which may have impacts on ecosystem and human health. (Sharon Smith, Geological Survey of Canada)	CF-as stated lower in this para
15-1147	A	36	14			there is possibly an alternative perspective to cover here which, while straying into politics, should not be ducked – while much is correctly made of the external threats to “indigenous” cultural life, it is also the case that these cultures develop, in some cases in a fashion deleterious to their environment. For instance, changes in both transport and hunting equipment (ie skidoos and guns) allow much more rapid coverage of wider areas, and greater kill frequencies, which are themselves both a threat to the fauna subject to these hunts, and a real change in the culture concerned. To be balanced, the report should include both sides – indigenous cultures cannot simply be kept in an isolated bubble, and pass all responsibility for the consequences of change on to others in the “outside”, and neither should the	CF-TO ADD SOMETHING ON MODERNITY

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						simple use of the word "indigenous" give an automatic right to continue any particular activity (Peter Convey, British Antarctic Survey)	
15-1148	A	36	39	37	29	Section 15.4.7 seems rather out of place. Can I suggest that the section on Arctic coastal erosion (15.4.7.1) be moved to the terrestrial section (15.4.2), and that the other two sections be expanded and included within other appropriate sections of this chapter (15.4.7.2 in the Antarctic terrestrial section and 15.4.7.3 wherever appropriate in the two marine sections). (Ian Joughin, Applied physics Lab, University of Washington)	Such a restructuring is not possible at this stage. Some re-arrangements of the text were made in response to this comment.
15-1149	A	36	41			the section on coastal erosion: Not all Arctic regions are vulnerable to coastal change - areas characterized by communities located in resistant bedrock coasts and where glacio-isostatic rise is occurring are less vulnerable to erosion. Furthermore - regional differences in sea level rise around the region are poorly understood and predicted SLR is very uncertain (models differ widely) (Steven Solomon, Geological Survey of Canada)	Text changed, appropriate reference will be very helpful.
15-1150	A	36	43	37	2	The ebb and flow of near shore sea ice is a much stronger control on coastal erosion issues than sea level change, at this time. An increase in open water season length, especially into the fall, has a dramatic impact on erosion. This section should reflect this fact. (OK I see it is touched on on pg 40, but it should really appear here) (David E Atkinson, University of Alaska Fairbanks)	As noted, it is on page 40.
15-1151	A	36	43	37	18	This section seems to be exclusivley concerned with coastal erosion.. No consideration is given to storm surges, flooding, ice ride up, impacts on port development, navigation etc. (Philip Hill, Geological Survey of Canada)	Many of these issues have been already addressed in TAR. Economical aspects are discussed further in the text of the chapter.
15-1152	A	36	43	36	47	Agree. It is very important to state clearly that it is the rising relative sealevel that is the biggest threat. Not reduced ice cover. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted
15-1153	A	36	43	37	18	To what extent does this section overlap with material in other Chapters? (Robert Jefferies, University of Toronto)	This will become more clear when other chapters prepare their SODs.
15-1154	A	36	47	36	48	Ice-rich permafrost terrain (Jerry Brown, International Permafrsot Association)	Text changed
15-1155	A	36	47	36	49	Can some references be added for the Canadian western Arctic (Solomon, Pollard?) (Sharon Smith, Geological Survey of Canada)	# FEN to address. Full references to published papers will be useful
15-1156	A	36	49	37	2	Not only high summer air temperatures but also higher mean annual temperatures promote these processes through the coastal permafrost warming that makes it more vulnerable for thermal and mechanical erosion (Vladimir Romanovsky, University of Alaska Fairbanks)	References to specific publications are need to support this statememt.

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15-1157	A	37	0			Section 15.5 Adaptation: This is another section that could be cut significantly as it mostly rehashes points made earlier. (Ian Joughin, Applied physics Lab, University of Washington)	Text was shortened.
15-1158	A	37	4	37	18	This section could also mention that defensive measures can result in severe, unanticipated erosional effects. (David E Atkinson, University of Alaska Fairbanks)	Need supporting publications.
15-1159	A	37	4			there is possibly an alternative perspective to cover here which, while straying into politics, should not be ducked – while much is correctly made of the external threats to “indigenous” cultural life, it is also the case that these cultures develop, in some cases in a fashion deleterious to their environment. For instance, changes in both transport and hunting equipment (ie skidoos and guns) allow much more rapid coverage of wider areas, and greater kill frequencies, which are themselves both a threat to the fauna subject to these hunts, and a real change in the culture concerned. To be balanced, the report should include both sides – indigenous cultures cannot simply be kept in an isolated bubble, and pass all responsibility for the consequences of change on to others in the “outside”, and neither should the simple use of the word “indigenous” give an automatic right to continue any particular activity (Peter Convey, British Antarctic Survey)	Noted
15-1160	A	37	4			coastal instability not coastal stability (Steven Solomon, Geological Survey of Canada)	Accepted
15-1161	A	37	6	37	11	cause and effect have not been substantiated; see earlier comment; use specific chapter in ACIA 2005 (Jerry Brown, International Permafrsot Association)	Noted. All references to ACIA report will be made in a standardized way.
15-1162	A	37	8			Shishmaref is probably not the best example for this case (Vladimir Romanovsky, University of Alaska Fairbanks)	#FEN to address
15-1163	A	37	8	37	12	It is important to note that while Tuktoyaktuk suffers from chronic erosion problems, at present there is no trend that can be identified or ascribed to a trend in climate. The monitoring record is dominated by the effects of infrequent, severe storm events. These will likely become more frequent if sea ice cover declines in the fall.. (Steven Solomon, Geological Survey of Canada)	#FEN to address
15-1164	A	37	11			unclear antecedent to "this Inuvialuit community" (John Calder, National Oceanic and Atmospheric Administration)	Accepted
15-1165	A	37	11	37	12	Not clear what community is being referred to here. (Philip Hill, Geological Survey of Canada)	Accepted
15-	A	37	11			subject and direct object mismatch…."For example, in Shishmaref (Alaska, USA)	Accepted

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1166						and Tuktoyaktuk… ...in this Inuvialuit community" (Larry Hinzman, University of Alaska Fairbanks)	
15-1167	A	37	12			Does this refer to one or both? (Gordon McBean, University of Western Ontario)	Accepted, changed to both.
15-1168	A	37	12	37	18	It is not obvious to me that a short term change in rates of coastal erosion need have any climatic significance. One could easily imagine natural variability in erosion rates related to things such as the cyclic dynamics and migration of offshore barriers for instance. It seems to me that site context is critical to the interpretation of these observations and this is not provided. (Martin Sharp, University of Alberta)	Noted
15-1169	A	37	14	37	16	be more specific as to where average 3C is for (on coast , over ocean etc) what causes the increase in erosion (thaw??) (Jerry Brown, International Permafrsot Association)	#FEN
15-1170	A	37	18	37	18	be more spepcifc as to where Nelson Lagoon is located and use ACIA 2005 chapter. (Jerry Brown, International Permafrsot Association)	There is no place to give the location of all sites here, these may be picked up from the map. ACIA will be cited in a standardized format
15-1171	A	37	18			Also in NE Greenland we have seen heavy coastal recession, with an old trapping station falling over the edge, and an up to 3.2m recession at four monitored sites at Zackenberg (see page 29-31 in Rasch, M. & K. Caning (eds) 2004: Zackenberg Ecological Research Operations, 9th Annual Report, 2003. - Danish Polar Center, Ministry of Science, Technology and Innovation (91 pp.). (Hans Meltofte, National Environmental Research Institute)	# FEN reference added
15-1172	A	37	26			Section 15.4.7.3 If materials of Working Group I will provide adequate information on expected key future impacts and vulnerabilities in terms of Shelf Processes? (Vladimir Romanovsky, University of Alaska Fairbanks)	We believe that all the material on shelf processes is split into the other sections, and the header has been removed.
15-1173	A	37	32			section 15.5 – there is possibly an alternative perspective to cover here which, while straying into politics, should not be ducked – while much is correctly made of the external threats to "indigenous" cultural life, it is also the case that these cultures develop, in some cases in a fashion deleterious to their environment. For instance, changes in both transport and hunting equipment (ie skidoos and guns) allow much more rapid coverage of wider areas, and greater kill frequencies, which are themselves both a threat to the fauna subject to these hunts, and a real change in the culture concerned. To be balanced, the report should include both sides – indigenous cultures cannot	We will state why there is an apparent bias towards indigenous lifestyles, response We do include examples of positive benefits in the chapter, and we believe that those are sufficient Covered above.

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						simply be kept in an isolated bubble, and pass all responsibility for the consequences of change on to others in the "outside", and neither should the simple use of the word "indigenous" give an automatic right to continue any particular activity. (Peter Convey, British Antarctic Survey)	
15-1174	A	37	32	39	5	Should this include a paragraph on networks of protected areas within both the Arctic and Antarctic? I should also like to see something here on monitoring the effects of climate change on biodiversity. The CBMP – Circum-polar Biodiversity Monitoring Programme – was launched in Cambridge last September, and I certainly think that the CBMP is one of the adaptation practices that should be included in this chapter. I do not know what monitoring is taking place, or is planned, for the Antarctic, but again this would be useful in understanding what is happening to the continent's biodiversity and maybe in planning for adaptation strategies. (Peter Doran, University of Illinois at Chicago)	TVC: We could possibly include something like " Conservation will become an increasingly important adaptation strategy as native polar habitats, flora and fauna become threatened by climate change, particularly where this interacts with other socio-economic and environmental changes. Current protected areas and their management regimes are not currently designed to reduce the impacts of climate change (Callaghan et al., 2005; Usher et al., 2005 (both in ACIA)). There is a pressing need to document the current biodiversity of the Arctic, to identify, monitor and record changes in this biodiversity and to develop new approaches to managing the Arctic's biodiversity (Usher et al., 2005)." Note: I would not refer to individual monitoring or research programmes like the reviewer suggests.
15-1175	A	37	32	39	5	Although this section is highly relevant, I do feel that the content overlaps with previous material and in any event the section could be edited and reduced to meet length constraints. The same applies to section 15. 6.1. (Robert Jefferies, University of Toronto)	CF-TO EDIT TO CHECK REDUNDANCY
15-1176	A	37	32	39	5	This section focuses somewhat too heavily on only 10% of the population in the Arctic. While understandable, addressing adaptation strategies of indigenous people almost exclusively is nevertheless inappropriate. Some more room should be given to the non-indigenous part of the population (the sentence on p. 38, lines 32-33 does not make much sense to me). (Manfred Lange, University of Muenster)	We believe that the recent research and political profile of "indigenous issues" requires this emphasis. CF-WILL CHECK FOR NON-INDIGENOUS DATA THOUGH IF POSSIBLE….EXPLANATION AT THE FRONT END SHOULD EXPLAIN THIS SITUATION – MOST VULNERABLE REFS AND THIS IS REFLECTED IN THE

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							LITERATURE AS WELL It seems that we cannot do more than currently done, although we sympathize with the reviewer. The chapter would look very different if we focused on climate impacts on the industry, agriculture, forestry and city infrastructures of the Faroes, Iceland, Northern Norway, Sweden, Finland, Russia, Alask and Canada. Also, this type of impact should be taken up perhaps by the regional chapters such as North America etc.
15-1177	A	37	32			Section 15.5: The plenary document calls for greater attention to responses to impacts. Yet, Section 15.5 is only a page or so long compared with much more lengthy sections on projected changes, etc. (Marybeth Long Martello, Harvard University)	CF-plenary document ? …
15-1178	A	37	32	39	5	Maybe it would be more fair to calculate the carbon dioxide emission pro capita in the Arctic for comparison with more southern nations. This might give a quite different picture. In Greenland, I have seen cars with permanently running motors from September until May and house heating regulated by opening or closing windows like in the lod days in Russia. (Hans Meltofte, National Environmental Research Institute)	
15-1179	A	37	32	39	5	Much discussion on the Arctic peoples here and elsewhere in the chapter seems to be pre-TAR knowledge. If the chapter needs to be shortened, I would suggest eliminating some of the pre-TAR knowledge about Arctic peoples. (Claire Parkinson, NASA Goddard Space Flight Center)	CF-WILL CHECK TO REFINE
15-1180	A	37	34	37	41	This paragraph is misleading. While it is true that impacts are stronger in the North, and therefore adaptation is a greater burden, it is not necessarily true to suggest that mitigation responsibility is less. You list that the Arctic nations are responsible for 40% of global emissions but that the people of the arctic contribute a small component. I live in the North, and here in North America the per capita emissions in the North are on par with national averages (and of course the US and Canada come in as the two highest emitters per capita). Bottom line is that we have an equal responsibility to mitigate and an uneven burden to adapt. The message you are delivering currently in the this draft encourages the cycle of blaming and shirking of responsibility. (John Streicker, Yukon College)	CF-THIS IS A COMPARATIVE PT…SHOULD BE STRENGTHENED IN THIS DIRECTION
15-	A	37	48	37	49	This should be expanded to clarify what is meant.	CF-to consider

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
1181						(Gordon McBean, University of Western Ontario)	
15-1182	A	38	6	38	9	It is very important to emphasize that one of the main reasons arctic villages are undergoing such severe impacts due to erosion is the fact that their mobile capacity has been removed in the last 50 years as they have had infrastructure build for them (e.g. power plants, water plant, school, medical bulding). This does not enter the debate about whether or not it is a good thing, or what aspects of quality of life or culuural issues it raises, but the fact remains that these coasts have always been unstable, and to establish permanent structures in the path of the erosion can have only one ultimate outcome. (David E Atkinson, University of Alaska Fairbanks)	CF-EXPRESSED IN OTHER SECTIONS…
15-1183	A	38	11	38	20	I would make this one paragraph. (Michael MacCracken, Climate Institute)	CF-accepted
15-1184	A	38	11			E.g. institutions such as indigenous languages (John Streicker, Yukon College)	CF-TEK IS NOT AN INSTITUTION IN THE CONTEMPORARY SENSE OF THE USE OF TERM “INSTITUTION” as used here
15-1185	A	38	18	38	18	Don't dogs detect "unsafe" conditions rather than "safe" ones? (Michael MacCracken, Climate Institute)	CF-YES
15-1186	A	38	23	38	26	The use of the term "western" in these two cases is no longer appropriate. Many goods come from other than what are traditionally called "western countries" and the science is done also more widely. Need to update one's lexicon on this. (Michael MacCracken, Climate Institute)	CF-to consider
15-1187	A	38	32	38	33	surely there is more to say about non-indigenous people and their need for adaptive strategies. As stated in the early part of the chapter, the indigenous people are about 10% of the population. The other 90% are going to have to deal with the changes too. Can they expect governments to relocate them or pay for structural damage from permafrost thawing? I doubt it, so how will the needed adaptations be financed? An entire section could be written on the social and economic adaptations that the non-indigenous people and businesses are going to face. (John Calder, National Oceanic and Atmospheric Administration)	CF-TRUE…BUT DATA ? TO SUPPORT IT…MOST LIT IS ON INDIGENOUS POPS (see comments in general comment #5)
15-1188	A	38	32	38	33	This paragraph needs some elaboration--they represent 90% or so of the people of the Arctic and they deserve more consideration. (Michael MacCracken, Climate Institute)	CF-accepted
15-1189	A	38	35	38	35	Change "within some changes" to "as par of the effort to adapt to other types of changes that" (Michael MacCracken, Climate Institute)	CF-accepted
15-1190	A	38	36	38	36	Need to change "or" to "and" as both happen. (Michael MacCracken, Climate Institute)	CF-accepted

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15-1191	A	38	38	38	39	Change "however to take" to "taking" and "impacts requires" to "impacts, however, will require" (Michael MacCracken, Climate Institute)	CF-accepted
15-1192	A	38	38	32	33	This sentence requires elaboration. What are these ties and what are their implications for adaptation? Even with this elaboration, this section will focus primarily on indigenous peoples. The section should include a few sentences on the rationale for this focus. (Marybeth Long Martello, Harvard University)	CF-to consider
15-1193	A	38	45	38	46	Change "means that" to "has affected how" (Michael MacCracken, Climate Institute)	CF-accepted
15-1194	A	38	49	38	49	Change "things" to "aspects of their lives" and change "or" to "and" (Michael MacCracken, Climate Institute)	CF-accepted
15-1195	A	39	0			Section 15.6.1: Again this is very repetitive (this is the second time we here about difficulties of moving on receding sea ice). (Ian Joughin, Applied physics Lab, University of Washington)	CF-to review and reduce redundancy
15-1196	A	39	3	39	3	Change "An understanding" to "Ultimately, an understanding" (Michael MacCracken, Climate Institute)	CF-agreed, accepted
15-1197	A	39	8			Section 15.6: The purpose of the case studies is not clear. I would expect useful case studies to bring together various facets of the chapter into concise examples. So each case study would explore social and environmental changes, sensitivity, adaptive capacity, and vulnerability for a particular community and the environment on which they depend or for a particular issue or problem manifest at one or more locations throughout the Arctic. So, each case study would examine, not only the biophysical manifestations of climate change, but also their interactions with human systems and perhaps with other environmental phenomena. At this point, none of the case studies provides this holistic picture, and the latter two do not really address implications for people. The case studies should be further developed along these lines or dropped. (Marybeth Long Martello, Harvard University)	This case study is part of cross-chapter case study and so is highlighted as part of a thread running thought the entire volume, and is justitfied on that basis. But is nonetheless important in its own right dues to the recent progress made.
15-1198	A	39	12	39	13	The aforementioned redundancy (James McCarthy, Harvard University)	CF-accepted
15-1199	A	39	13	39	13	Change "which" to "whom" (Michael MacCracken, Climate Institute)	CF-accepted
15-1200	A	39	20	39	20	I would suggest changing "and culturally" to "incorporated into their social practices and cultures, and" (Michael MacCracken, Climate Institute)	CF-accepted to edit
15-	A	39	27	39	27	I would suggest changing this to "knowledge base provides an invaluable	CF-will consider

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1201						foundation and framework for developing …" (Michael MacCracken, Climate Institute)	
15-1202	A	39	33	39	35	Some repetition here - compare with Ln 42-44 on the page 38 (Vladimir Romanovsky, University of Alaska Fairbanks)	CF-to edit to reduce redundancy
15-1203	A	39	36	39	36	Change "without" to "without creating" (Michael MacCracken, Climate Institute)	CF-accepted to edit
15-1204	A	39	39	33	37	Not a proper sentence. (Marybeth Long Martello, Harvard University)	CF-accepted to edit
15-1205	A	39	40			Is it "despite" rather than "because of" ? (Gordon McBean, University of Western Ontario)	CF-incorrect…it is an adaptive response that is resulting in changed routes…
15-1206	A	39	41	39	43	I would suggest wording this something like "to locate and hunt traditional species such as geese and caribou that have shifted their migration times and routes, and to begin to locate and hunt alternative species moving into the region" (Michael MacCracken, Climate Institute)	CF-accepted to consider rewording
15-1207	A	39	45	39	45	I would suggest changing "unpredictable" to "uncharacteristic" as a more appropriate description of the situation. (Michael MacCracken, Climate Institute)	CF-like the suggested wording…although prediction is also part of the intended meaning. To consider rewording.
15-1208	A	40	1	40	3	I would suggest revising this to read "These examples are indicative of the adaptive challenges being faced by residents of arctic indigenous societies and the critical interactions between indigenous knowledge and adaptive capacity." (Michael MacCracken, Climate Institute)	CF-like the rewording suggested. Accepted to be reworded.
15-1209	A	40	6			This heading needs some explanation - which other chapters? (James McCarthy, Harvard University)	Other chapers to be identified.
15-1210	A	40	8	40	8	Change "populate" to "are located along" (Michael MacCracken, Climate Institute)	Text changed as suggested.
15-1211	A	40	9			something is very wrong with these numbers - the deltas are nowhere near this large. Even the entire watershseds are much smaller than 44 million square km, the huge Lena basin is about 2.5M. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Typographical error in size of catchments has been changed, i.e., from 10^6 to 10^3
15-1212	A	40	10			delete 'draining' (Peter Johnson, University of Ottawa)	“draining” changed to “fed by”
15-1213	A	40	10	40	10	Change "draining the" to "which are the" (Michael MacCracken, Climate Institute)	“draining” changed to “fed by”
15-1214	A	40	12	40	16	OK the importance of sea ice for coastal erosion is indicated here, but it must be emphasized alongside the the sea level rise part. These considerations apply over the entire arctic coast, not just deltas! (David E Atkinson, University of Alaska Fairbanks)	Agreed, but this case study is to focus only on mega-deltas for comparison to other similar case studies in other chapters.

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15-1215	A	40	14	40	14	Change "protection will" to "protection with warming will" (Michael MacCracken, Climate Institute)	Text added as suggested.
15-1216	A	40	17	40	18	thawing not melting (Jerry Brown, International Permafrsot Association)	Text changed as suggested.
15-1217	A	40	17			"melting of the permafrost" permafrost does not melt, it thaws (Larry Hinzman, University of Alaska Fairbanks)	Text changed as suggested.
15-1218	A	40	17			Should be "… thawing of permafrost and melting of the ground ice…" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changes as suggested.
15-1219	A	40	18			"melting of the permafrost" (Larry Hinzman, University of Alaska Fairbanks)	Text changes as suggested.
15-1220	A	40	18	40	21	It will depend on the topography, ground water level, and drainage conditions. It could be more or less water on/at the ground surface depending on those factors (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changed to suggest that this is only an example of potential changing conditions.
15-1221	A	40	18			Again, should be "thawing of permafrost" instead of "melting permafrost" (Vladimir Romanovsky, University of Alaska Fairbanks)	Text changes as suggested.
15-1222	A	40	18	40	21	the thickneing active layer in deltaic environments may lead to thaw subsidence and lowering of the ground surface affecting magnitude and frequency of flooding both from spring freshet and storm surges. (Kokelj and Burn 2005 - Permafrost and Periglacial Processes v16, 291-303) (Steven Solomon, Geological Survey of Canada)	Additional text added to this effect and reference added.
15-1223	A	40	28			The Peace-Athabasca delta is not on the Mackenzie River proper. Insert "watershed" after Mackenzie River (Laurence C. Smith, University of California, Los Angeles (UCLA))	Text added as suggested.
15-1224	A	40	29			The phrase "due to smaller winter snowpack" is not in agreement with the previous statements about the increase in winter precipitations (Vladimir Romanovsky, University of Alaska Fairbanks)	Smaller winter snowpacks noted in literature to result because of increased winter rainfall. Text changed to clarify.
15-1225	A	40	30	40	30	For clarity, change "This" to This change" (Michael MacCracken, Climate Institute)	Text added as suggested.
15-1226	A	40	40			With the Antarctic Peninsula warming so rapidly (see 15.6.3), I feel that some of the data could be included in this review. (Michael Usher, University of Stirling)	This is a nice idea – I wonder if we could fit it in – data that sits between drivers and impacts is the increase in melt-days that's just been published by DGV.
15-1227	A	40	42			Comment on para. Should note that changes in the Antarctic Peninsula are not represenatative of the Antarctic as a whole. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	# Can we fit such a statement in?
15-1228	A	40	42	40	43	grammar use 'protruding' or 'which protrudes' (Peter Johnson, University of Ottawa)	Accepted

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15-1229	A	40	42			Word missing. (Hans Meltofte, National Environmental Research Institute)	Accepted
15-1230	A	40	42			correct grammar in this sentence (Laurence C. Smith, University of California, Los Angeles (UCLA))	Accepted
15-1231	A	41	2	41	6	Information about other key climatic parameters variability should be added to description of temperature increasing, e.g.: "Over Antarctic Peninsula the significant mean sea level pressure decreasing (Turner et al., 2005) and cloud cover increasing (Chernykh et al., 2005) is detected, which indicates the cyclone activities intensification over Antarctic Peninsula". Corresponding reference: Chernykh, I.V., O.A. Alduchov and V.E. Lagun, 2005: About Climatic Changes of Clouds and Precipitation over Antarctic Peninsula. Research activities in atmospheric and oceanic modelling. CAS/JSC Working Group on Numerical Experimentation Report (Ed. Ritchie H.), N 35. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Space limitations preclude a detailed discussion here. Noted
15-1232	A	41	8	41	8	"ice shelves have retreated with loss of around" should read 'ice shelves have retreated with a loss of around' (Bruce Forbes, University of Lapland)	Accepted
15-1233	A	41	10	41	11	the melt of seasonal sea ice would not increase the sea level but the calving of floating ice shelves could. The latter are usually anchored on some islands, accumulates a lot of snow, and are not really floating like sea ice. (Josefino Comiso, NASA Goddard Space Flight Center)	We dispute that this effect could cause any measurable impact on sea level.
15-1234	A	41	10	41	10	… loss of seasonal snow and floating ice …. (Peter Lemke, Alfred Wegener Institute)	Accepted
15-1235	A	41	11			increased' delete 'and' before acceleration (Peter Johnson, University of Ottawa)	
15-1236	A	41	12		14	"an increased supply of melt water to glacier beds will cause an increased contribution to sea level rise." I don't agree with this statement – surely – it is increased runoff from the ice mass that raises sea level? Supply of water to glacier beds does not directly increase sea level (although it may affect glacier dynamics and thus sea level indirectly). (Tavi Murray, University of Wales Swansea)	# The train of logic described was intended to be implied, but could be made more explicit Actually, the sentence is correct, and is clear when read without the references.
15-1237	A	41	13	41	15	Seems to me that this is pure speculation based on very scanty evidence. It is not at all obvious to me that increasing meltwater inputs to glacier beds will necessarily produce accelerations of flow that can be sustained indefinitely. There may well be negative feedbacks involving drainage system evolution - as is the case in many	Accepted – we will revise to make the point about the longevity of change

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						smaller glacier systems. (Martin Sharp, University of Alberta)	
15-1238	A	41	14	41	14	Change "continues these" to "occurs as is projected, these (Michael MacCracken, Climate Institute)	We don't know of any study that makes such a prediction!
15-1239	A	41	17	41	18	The English needs adjusting in the first part of this sentence. (Robert Jefferies, University of Toronto)	Accepted
15-1240	A	41	18			I would change 'but' to 'and' to make a better flow with next sentence. (Ted Scambos, University of Colorado)	Accepted
15-1241	A	41	20	41	20	the retreat of sea ice in the B/A seas was studied in detail by Jacobs and Comiso (1997). The retreat in the B/A seas was compensated by advances in the ice cover in the adjacent Ross Sea cause almost no net loss or gain in the entire Antarctic sea ice cover. The ice cover in the B/A seas has recovered significantly since, while the rate of advance in the Ross Sea is also now more moderate. (Josefino Comiso, NASA Goddard Space Flight Center)	We note the precedence of earlier work but we are aiming to cite the most up to date sources. The fact that change may have slowed in recent years does not diminish the long-term changes.
15-1242	A	41	20	41	20	Change "is related" to "appears to be related" (Michael MacCracken, Climate Institute)	Can there be any doubt? Here I think that high confidence is warranted
15-1243	A	41	22			Order of words? (Hans Meltofte, National Environmental Research Institute)	Accepted
15-1244	A	41	23	41	26	If I understand what is meant here, I think it would make a bit more sense to reverse the order of the sentences and say "The warming on the west coast is limited to the lower troposphere (Marshall et al, 2002). It has been shown that this warming is correlated with changes in the atmospheric circulation (van den Broeke and van Lipzig, 2003) and that these changes in circulation are likely to have been caused by anthropogenic influences (Marshall et al, 2004)." (Michael MacCracken, Climate Institute)	Accepted
15-1245	A	41	25			Sees to imply that the Southern Annular Mode is an anthropogenic feature - I don't know that there is any basis for such a suggestion. (Martin Sharp, University of Alberta)	Accepted
15-1246	A	41	25	41	26	The sentence "The warming on the west coast is limited to the lower troposphere (Marshall et al., 2002)" is not full. In fact, warming here is extended to the lower, middle and high troposphere (Marshall et al., 2002). The significant cooling is detected over lower stratosphere (Marshall et al., 2002). (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Check
15-1247	A	41	26	41	29	I think it would be clearer if this said "Current model simulations do not replicate the observed warming …. Continue in the future, limiting out ability to project the likely impacts."	Accepted

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						(Michael MacCracken, Climate Institute)	
15-1248	A	41	26	41	34	In view of the statement on lines 27-28 that "there is little basis for prediction that rapid warming will continue", I would eliminate lines 31-33 plus "However," at the start of line 34. (Claire Parkinson, NASA Goddard Space Flight Center)	Noted
15-1249	A	41	26	41	29	Why does a difficuly in predicting future climate warming render assessment of the impacts of such warming problematic? Surely predicting impacts of an assumed warming is no more speculative than predicting the impacts of a model prediction of warming? (Martin Sharp, University of Alberta)	Accepted
15-1250	A	41	31	41	33	Would not continued present warmth also cause these impacts--do we really need to warm further? Are we at equilibrium now with respect to impacts? (Michael MacCracken, Climate Institute)	Difficult to say, if further impacts will result from maintained temperatures, without warming.
15-1251	A	41	31	41	31	Revise wording to read "Notwithstanding uncertainty regarding the cause (or causes) of recent warming …" (Michael MacCracken, Climate Institute)	Noted
15-1252	A	41	31			Page 41 last paragraph. This needs a sentence to say that no alien species have been documented establishing themselves in the Southern Ocean to date. Extra bullet points for the key uncertainties on P44 should include: Trends in Sea ice The extreme vulnerability of polar biotas to change and how their feedbacks might work The ability to predict future ocean productivity How polar changes will affect the deep sea through the deep ocean currents. (Lloyd Peck, British Antarctic Survey)	This is not required.
15-1253	A	41	37	41	38	II would think better wording would be "growing threat of invasion by non-native species, encouraged by …" Are there many species there? Is this really an invasion, or a shift in ecosystems with climate? (Michael MacCracken, Climate Institute)	Alien invasion is used in the literature and so is reflected here.
15-1254	A	41	40	41	42	The general description of the Antarctic Peninsula warming process should also include information about local greenhouse gases emission, e.g. sentence like this: "Permafrost degradation detected in sub-Antarctic Islands leads to methane and nitrous oxide emission into the atmosphere from ornitogenic soils (Atmospheric Environment, 2002)". (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Thanks, but this is likely to be such a small effect on a global scale that space limitations preclude its inclusion.
15-	A	41	49			more far reaching impacts, perhaps even affecting C02 sequestration... This is	It's a complex sentence but I think it's

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1255						vague and unclear-rewrite please. (Robert Jefferies, University of Toronto)	readable. But will look for simplification in revision
15-1256	A	42	0	43		Coverage of economic impacts of climate change is brief and disappointing here. The most severe impacts are likely to occur in this sector. While there are good descriptions in other parts of the chapter of economic impacts they should be added here (Gunter Weller, University of Alaska)	This section to be revised
15-1257	A	42	2	42	6	The impacts of the Antarctic circumpolar wave, SAM and ENSO should also be discussed. There are recent papers regarding these topics. (Josefino Comiso, NASA Goddard Space Flight Center)	This is a more appropriate discussion to have in WGI – and space limits discussion here.
15-1258	A	42	3	42	13	coatal erosion is being used too many times without widespread evidence that climate change is the cause and that it is accelerating. (Jerry Brown, International Permafrsot Association)	
15-1259	A	42	3	42	6	Given the effects of air and water transport, human influence is not necessarily at a minimum in seemingly "isolated" locations. It would be better to add "in-situ" before "human influence" on line 6. (Claire Parkinson, NASA Goddard Space Flight Center)	Accepted
15-1260	A	42	4			new sentence at 'This is a (Peter Johnson, University of Ottawa)	Accepted
15-1261	A	42	4	42	5	I would suggest revising to read "and are a dramatic reminder of the regionality to be expected from future climate change, and the complexity of impacts …" (Michael MacCracken, Climate Institute)	Accepted
15-1262	A	42	5			…..'and the complexity' (Peter Johnson, University of Ottawa)	Accepted
15-1263	A	42	9	42	9	in my Febreuay 2005 review I asked that a reference to Hayley be included: Don W. Hayley, 2004. Climate Change — An Adaptation Challenge for Northern Engineers. Association of Professional Engineers, Geologists and Geophysicists of Alberta. http://www.apegga.org/whatsnew/peggs/Web01-04/expert.htm.This section neds referecne to ACIA 2005 infrastructure chapter 16 (see Instanes reference). (Jerry Brown, International Permafrsot Association)	Reference added.
15-1264	A	42	9	43	39	This section on “economic activity and infrastructure in the Arctic” addresses almost exclusively the impacts of climate change on permafrost and their repercussions for arctic residents and infrastructure. However, there are quite a few other sectors that need to be addressed in this context, most notably changes in terrestrial ecosystem and implications for forestry as well as climate impacts on marine ecosystems and their consequences for the fisheries industries. In my view	NO ACTION for TVC nfo for Maggan Better covered in other regional chapters

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						these sectors are of greater importance compared to the permafrost issues addressed here. The problem of increased transport activities along the Northern Sea Route or along the North American coast and associated contamination of marine ecosystems is only slightly introduced. (Manfred Lange, University of Muenster)	
15-1265	A	42	11			This chapter need to include some discussion about the possible increase in the shipping and in the explotation of hydrocarbon in the Arctic (Jari Haapala, Finnish Institute of Marine Research)	TVC and others to consider but TVC cannot cover forestry which is a boreal topic
15-1266	A	42	11			This section leaves out the important work being done in Quebec - by Ouranos and provincial government and the ACIA report - Chapter 16 by Instanes. (Gordon McBean, University of Western Ontario)	Reference to ACIA report is added, as well as references to other relevant publications
15-1267	A	42	11	43	39	It seemed surprising that oil and gas exploration and exraction aren't mentioned in this section. There would seem to be a broad spectrum of related topics inclding ice roads, building, rig, and pipe line structures. On the sustainability topic the question of potential spills also arises (James McCarthy, Harvard University)	Noted, text changed.
15-1268	A	42	11	43	39	Mostly on permafrost. What about shipping (only mentioned in terms of tourism), offshore oil and gas exploration, production, and transport; minerals; forestry and agriculture, etc. Thia section is very weak. (Gunter Weller, University of Alaska)	Noted, text on oil and gas exploration facilities added.
15-1269	A	42	14	42	16	I would refer to the ACIA-report. This statement is much too strong. Climate warming may increase existing problems, but the lifespan of a structure in the Arctic is maybe 20-30 years. It does not make sense to design infratructure for longer service life. The ability for adaptation is very high (excluding coastal areas where the only solution to coastal erosion is relocation). (Arne Instanes, OPTICONSULT Consulting Engineers)	All statements in this sentence are further discussed in the text and are supported by publications, including the ACIA report.
15-1270	A	42	15	42	15	Change "may" to "are likely to" (Michael MacCracken, Climate Institute)	Noted
15-1271	A	42	20	42	21	Smith and Burgess (2004) also examined the sensitivity of permafrost in Canada to climate warming and developed a sensitivity index (this built on earlier work published in 1998 and 1999). The potential for thaw settlement was the main hazard associated with permafrost thaw that was examined by Smith and Burgess. The results of their work indicated that areas of high sensitivity in the Mackenzie Valley. It is important to mention other studies done at a national scale in addition to those at a global scale. It is also important to mention other studies that have produce sensitivity or hazard maps. (Reference: Smith, S.L. and Burgess, M.M.	Noted, reference added

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						2004. Sensitivity of permafrost in Canada to climate warming. Geological Survey of Canada Bulletin 579.) (Sharon Smith, Geological Survey of Canada)	
15-1272	A	42	22	42	22	discontinuous high risk zone needs additonal explanation; is this a function of abundance of ground ice. If so, is that the reason for high potential erosion. (Jerry Brown, International Permafrsot Association)	This is a descriptive statement that is based on the calculations involving the hazard index. More details are given in the supporting publications.
15-1273	A	42	22	42	22	Change "scenarios yield" to "emissions scenarios lead to changes in climate that generate" (Michael MacCracken, Climate Institute)	Noted
15-1274	A	42	22	42	28	It should be distinguished between hazards related to coastal erosion and to thawing of inland permafrost. I am also not sure that Inuvik is a good example of a settlement affected by coastal erosion (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted, text changed
15-1275	A	42	22	42	23	"discontinuous high-risk zone" - requires explanation (Sharon Smith, Geological Survey of Canada)	It means that that part of the Arctic coast falls into the high-risk zone, while other parts do not, i.e. the high-risk zone is discontinuous.
15-1276	A	42	23	42	23	It is nothing new that sandy or silty sediments have a high potential for coastal erosion. Just look to any temeprate location; for example Florida or Denmark! If you add ice the problem will of course be magnified. This process (and high risk) has been present since the last glaciation. Sea-level rise will of course accelerate the process. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted, and the text says exactly what reviewer suggests.
15-1277	A	42	24	42	30	A number of these place names are missing from Fig !5.1 (Robert Jefferies, University of Toronto)	Figure is too small to show all the place names
15-1278	A	42	26	42	26	Can delete "fall within this zone" (Michael MacCracken, Climate Institute)	Noted
15-1279	A	42	28	42	30	This is correct. But the authors should be aware that this is the case with or without climate warming. The difficult (impossible?) part is to figure out the incremental increase in investment caused by climate change relative to all the other factors causing permafrost thaw (again I have to refer to the ACIA-report). The way the report is written, the reader gets the impression that everything we observe related to permafrost thaw, coastal erosion, infrastructure damage is caused by climate warming. Clearly this is not the case. IPCC should try to avoid these speculative implications and state physical facts, even though the matter is very complex. (Arne Instanes, OPTICONSULT Consulting Engineers)	As suggested by the reviewer, this is a correct statement and no action is needed.
15-	A	42	28	42	28	Should change "are" to "will be"	Noted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
1280						(Michael MacCracken, Climate Institute)	
15-1281	A	42	32	42	32	Change "discerning" to "differentiating" (Michael MacCracken, Climate Institute)	Noted
15-1282	A	42	33	42	36	While I generally agree with the message from this para, I don't think references to particular media reports are appropriate for a scientific assessment report. Having the tremendous amount of all sorts of climate-related "ideas" ranging from reasonable to stupid coming from mass media, I believe the IPCC Assessment should neglect them without any preference. (Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	Noted
15-1283	A	42	34	42	36	The statements implying that climate change is responsible is of course false. It is possible to do a back-calculation showing that it is not physical possible that observed climate change could have caused these problems and failures. I have probably made this statement 100 times - it doesn't matter people still blame climate change.. Please show me a calculation that gives evidence of observed climate change causing failure of a foundation on permafrost. Observed climate change may be "the drop" that caused a faulty structure to collapse, but that does not mean that alll the other factors creating the problem is "innocent". Observed climate change is NOT the root of the problem. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted. The statements in the text are supported by publications, and the mission of IPCC experts is not to debate them, but to give a comprehensive overview of the published literature.
15-1284	A	42	34	42	34	Change "human" to "buildings and other societal" (Michael MacCracken, Climate Institute)	Noted
15-1285	A	42	37	42	38	It is not just the impact of heated builidings that is important, warming of the ground can also occur in response to clearing of vegetation and the organic layer prior to construction. Burgess and Smith (2003) examine the impacts of pipeline right-of-way clearing in the Mackenzie valley on thaw depths and thaw settlement. This work also allowed the characterization of thaw strains for different terrain types which is also important in examining the impact of climate change on permafrost terrain. In addition, the results show that effects of climate variability were superimposed on the larger effects related to disturbance of the vegetation. (Reference Burgess and Smith 2003.Burgess, M.M. and Smith, S.L. 2003. 17 years of thaw penetration and surface settlement observations in permafrost terrain along the Norman Wells pipeline, Northwest Territories, Canada; Proceedings of 8th International Conference on Permafrost, July 2003, Zurich Switzerland, p. 107-112.) (Sharon Smith, Geological Survey of Canada)	This section is focused on the economic activities in the Arctic. The effects of vegetation on permafrost are thus not relevant here.
15-	A	42	39	42	39	Change "may be an important factor in" to "it is possible represent an important	Noted

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1286						factor in" (Michael MacCracken, Climate Institute)	
15-1287	A	42	42	42	50	this discussion has little to do with climate change; rahter poor siting of structures. One sentence is enough. (Jerry Brown, International Permafrsot Association)	It is relevant in the context of economic developments in the Arctic
15-1288	A	42	44	42	46	Speculative statements again. How many of the 350 structures are attributable to climate change? The reader gets the impression that: not all: i.e. many or most.. This is politics not science. Fairbanks is probably one of the most difficult permafrost sites in the Arctic. Warm permafrost (maybe just a couple of tenths of a degree C from the melting point) and ice-rich silty sediments (Fairbanks silt). ANY disturbance of the surface layer will cause permafrost thaw. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted. The statements in the text are supported by publications, and the mission of IPCC experts is not to debate them, but to give a comprehensive overview of the published literature.
15-1289	A	42	47			Word missing. (Hans Meltofte, National Environmental Research Institute)	Noted
15-1290	A	42	48	15	50	The English needs some adjustment (Robert Jefferies, University of Toronto)	Noted
15-1291	A	42	48	42	48	Change "being associated with" to "have been invested in what are becoming" (Michael MacCracken, Climate Institute)	Noted
15-1292	A	42	48	42	49	The meaning of the beginning of this sentence is not clear (Vladimir Romanovsky, University of Alaska Fairbanks)	Noted
15-1293	A	42	49	42	49	Change "structures, but" to "structures;" (Michael MacCracken, Climate Institute)	Noted
15-1294	A	42	50	43	1	It would read better to say "permafrost, it becomes effectively unmarketable because loans cannot be secured on it, causing a severe loss of value that can be devastating for individual investors." (Michael MacCracken, Climate Institute)	Noted
15-1295	A	43	0			Section 15-7.2: There are probably more words here than necessary to discuss the impact of Antarctic tourism. (Ian Joughin, Applied physics Lab, University of Washington)	Noted
15-1296	A	43	1	43	13	Other recent references which discuss possible impacts related to thawing of permafrost include: Smith, S.L., Burgess, M.M. and Heginbottom, J.A. 2001. Permafrost in Canada, a challenge to northern development; in A Synthesis of Geological Hazards in Canada, G.R. Brooks (ed.). Geological Survey of Canada Bulletin 548, p. 241-264. Couture, R., Smith, S., Robinson, S.D., Burgess, M.M. and Solomon, S. 2003. On the hazards to infrastructure in the Canadian North associated with thawing of permafrost; Proceedings of Geohazards 2003, 3rd Canadian Conference on	Noted, references added

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						Geotechnique and Natural Hazards, The Canadian Geotechncial Society, p. 97-104. (Sharon Smith, Geological Survey of Canada)	
15-1297	A	43	3	43	13	All this is correct - with or without climate change. Again, the reader gets the impression that these problems are caused by climate change, which is not the case. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted. There is a clear statement on P.42 line 32 about the difference in the effects of climate change and other factors.
15-1298	A	43	3	43	4	The quote from Couture et al. (2000) may be a bit innaccurate. The paper stated that geotechnical problems are anticipated to be more common leading to serious and costly problems or maintenance requirements for northern communities and infrastructure. A more important contribution of this paper and related publications (Couture et al. 2001, Chartrand et al., 2002) is that it discussed the need to understand the conditions of the underlying material and to provide databases that could be used by communities in their landuse planning. (References: Couture, R., Robinson, S.D. and Burgess, M.M. 2002. Climate change, permafrost degradation and impacts on infrastructure: two case studies in the Mackenzie Valley. 2001 An Earth Odyssey, Proceedings of the 54th Canadian Geotechnical Conference, Calgary, Vol 2, p. 908-915. Chartrand J., Lysyshyn K., Couture R., Robinson S.D., and Burgess M.M. 2002. Digital Geotechnical Borehole Databases and Viewers for Norman Wells and Tuktoyaktuk, Northwest Territories. Geological Survey of Canada, Open File Report 3912. CD-ROM. (Sharon Smith, Geological Survey of Canada)	Noted, reference added
15-1299	A	43	4	43	4	Change "could be overwhelming" to "is likely to far exceed available resources" to make clearer what the problem is. (Michael MacCracken, Climate Institute)	Noted
15-1300	A	43	5	43	13	I would suggest making this a separate paragraph. (Michael MacCracken, Climate Institute)	Noted
15-1301	A	43	5	43	5	I would suggest adding the phrase "often based on assumptions of a stable climate" after "criteria" (Michael MacCracken, Climate Institute)	Noted
15-1302	A	43	7	43	7	Containment holding facilities also include those designed to include mine tailings. (Sharon Smith, Geological Survey of Canada)	Noted
15-1303	A	43	7			e.g. tailing ponds at mine sites (John Streicker, Yukon College)	Noted
15-1304	A	43	11	43	11	I would suggest rewording to say "settlements is likely to be very costly; for example, a study" (Michael MacCracken, Climate Institute)	Noted
15-	A	43	15	43	19	This paragraph should also say something about the opening of the Northern Sea	Noted, it was already in TAR

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1305						Route. (Michael MacCracken, Climate Institute)	
15-1306	A	43	21	43	24	Couldn't agree more. (Arne Instanes, OPTICONSULT Consulting Engineers)	Noted
15-1307	A	43	21	43	39	It is also important to note that climate change needs to be considered in Environmental Impact Assessment in order to ensure sustainable development under a changing climate. In Canada climate change is now included in terms of references for environmental impact statements and proponent's must consider it in their analysis (The Canadian Environmental Assessment Agency is developing guidelines fo the inclusion of climate change). (Sharon Smith, Geological Survey of Canada)	Reference to publication(s) is needed to support this message.
15-1308	A	43	24	43	24	Change "These" to "The" and "probable" to "very likely" to be consistent with IPCC lexicon. (Michael MacCracken, Climate Institute)	Noted
15-1309	A	43	28	43	28	Delete "other"--this applies to all changes. (Michael MacCracken, Climate Institute)	Noted
15-1310	A	43	29	43	30	Change "does now appear" to "appears" (Michael MacCracken, Climate Institute)	Noted
15-1311	A	43	31	43	39	Comment on para. This seems more like a political statement that doesn't belong in a scientific and technical report such as the IPCC's AR4. Moreover, before any such endorsement is made, there should be, as a start, an analysis of the issue and a weighing of the various pros and cons. It would be best to drop everything from line 31 to 39. (Indur Goklany, Office of Policy Analysis, Department of the Interior)	Comment rejected. The information in the paragraph is true and correct.
15-1312	A	43	32	43	32	The Arctic Council does not have circum-arctic decisionmakring powers. It is not based on a treaty among the countries involved, but a declaration (1996). The countries have therefore not relinquished sovereingty to the council. A better wording would be to replace "reasonable framework" with "forum", and replace "decision-making" with "cooperation". (Alf Håkon Hoel, University of Tromsø)	This is a good point. Text changed.
15-1313	A	43	33	43	33	Change "states" to "nations" to avoid confusion. (Michael MacCracken, Climate Institute)	Noted
15-1314	A	43	36			change to read "the Arctic Council, in partnership with the International Arctic Science Committee, was responsible" (John Calder, National Oceanic and Atmospheric Administration)	Accepted, text changed
15-1315	A	43	36	43	39	Change "projects, but in" to projects. In" and then at end or paragraph add citation to "ACIA, 2004, 2005"	Noted

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Michael MacCracken, Climate Institute)	
15-1316	A	44	0			Key uncertainties This is a vital part of the chapter, and due to the high profile of the IPCC report internationally and at government level will help drive the research questions that the scientific community address over the next 5 years or more. The fact that these were incomplete was a key weakness of the chapter. As a glaciologist, a key item missing from this list was uncertainties related to our lack of knowledge of the future stability of the Greenland ice sheet, in particular the inability of current models to reproduce current observations and our lack of understanding of the sign of its contribution to sea level rise. (Tavi Murray, University of Wales Swansea)	ICARP II TVC TRC and others This seems a repeat of the issue brought up during ICARP II. The glaciologists seem to have fallen between chairs in ICARP II and maybe also IPCC if chapter 15 is supposed to cover all they are dealing with. But surely they are included elsewhere in IPCC..?? Anyway, I feel uneasy about answering this question since I do not have a full overview of this part of the IPCC process.
15-1317	A	44	0			The list of uncertainties is imcomplete. This could be made into a long laundry list of specific requirements, of course, but it would be useful to identify broad cross-cutting issues, including the following, for example: 1) The need for smaller-scale regional studies of impacts, where the people on the ground need ibetter nformation 2) More detailed study of economic impacts involving economists (see comment above) 3) Need for vulnerability studies in which other impacts (pollution, social change, economy etc) combine with climate change to threaten populations (Gunter Weller, University of Alaska)	Our section on key uncertainties requires complete reworking and we will take this and all other comments into account during that re-write.
15-1318	A	44	3	44	5	the number of stations are know (not simply a handful) and probaby their cost to maintain and operate are known. I would reword the significance as new Antarctic discoveries have global benefits. Antarctic contibution to Increase in sea level rise can have hugh economic impacts. (Jerry Brown, International Permafrsot Association)	Ditto
15-1319	A	44	3	44	4	Open sentence with phrase "As long as air and water quality are not endangered, the relatively …" and on line 4 change "human" to "local" (Michael MacCracken, Climate Institute)	Ditto
15-1320	A	44	7	44	20	This section on uncertainties is very important. It reflects the state of our knowledge about the Polar Regions. This should be made as quantitative and as complete as possible. It should also discuss how things improved from the previous IPCC report. (Josefino Comiso, NASA Goddard Space Flight Center)	Ditto
15-1321	A	44	7			Recent dramatic changes in the area of surface melt on the Greenland Ice Sheet, together with the loss of floating ice tonges below about 70 deg N and the speed up of major outlet glaciers, could be included as a bullet point.	Ditto

Chapter-Comment	Batch	From Page	From Line	To Page	To line	Comments	Notes of the writing team
						(Julian Dowdeswell, University of Cambridge)	
15-1322	A	44	7			Section 15.8 I think this section is very undeveloped. In my opinion, this chapter does not discuss the problems associated with threshold changes and feedbacks very well. I consider those two processes to be among the most important uncertainties limiting progress in predicting arctic climate changes and environmental responses. This is clearly the biggest deficiency with this chapter. (Larry Hinzman, University of Alaska Fairbanks)	Ditto
15-1323	A	44	7			Ability to quantify the role of feedbacks in controlling current and future climate dynamics. At present, it seems most feedback processes are positive. What is the control to slow climate change, now and in past rapid change events. (Larry Hinzman, University of Alaska Fairbanks)	Ditto
15-1324	A	44	7			Ability to predict the environmental and climatic responses after crossing such threshold events as complete degradation of sea ice, thawing of permafrost, drying of tundra lakes, shifts in dominant vegetation…. (Larry Hinzman, University of Alaska Fairbanks)	Ditto
15-1325	A	44	7			Length: this chapter is overlength by around 10 text pages, so some substantial trimming is required. This is especially the case since it is unfinished - Section 15.8 is incomplete. (Jean Palutikof, Hadley Centre)	In hand for SOD
15-1326	A	44	7	44	21	Suggested additional bullet: understanding of the extent to which sea ice changes are tied to oscillatory behaviors in the climate system, such as the Arctic Oscillation, Antarctic Oscillation, and North Atlantic Oscillation. (Claire Parkinson, NASA Goddard Space Flight Center)	Our section on key uncertainties requires complete reworking and we will take this and all other comments into account during that re-write.
15-1327	A	44	7			Section 15.8 is in its infancy (Vladimir Romanovsky, University of Alaska Fairbanks)	Ditto
15-1328	A	44	7			Section 15.8 - It will be important to mention here that monitoring of environmental parameters is important -- this includes global networks such as the Global Terrestrial Network for Permafrost but also local monitoring associated with individual significant projects such as mines, pipelines etc. (Sharon Smith, Geological Survey of Canada)	Ditto
15-1329	A	44	7	44	20	The section on the uncertainties needs a serious effort. The four existing bullets are all about the lack of ability "to predict" different aspects of climate change, and to my mind would fit better WG1 report (and will probably repeat messgares from e.g. Ch.10 and Ch.11 of the WG1). I think this is not the task of this chapter to discuss climate projection uncertainties, but to try to discuss uncertainties in determining advantages/disadvantages of the climate change for the ecosystems, economies and population of the polar regions.	Ditto

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						(Yuri Tsaturov, Russian Federal Service for Hydrometeorology and Environment Monitoring)	
15-1330	A	44	7	44	20	See my comments under GENERAL above (Gunter Weller, University of Alaska)	Ditto
15-1331	A	44	9	44	20	Some other key uncertainties (pertinent to the Arctic marine system). 1) understanding the role of atmospheric versus oceanic forcing on the current sea ice reduction; 2) understanding the role of different snow precipitation patterns on sea ice physical processes and coupling to marine ecosystem response (e.g., habitat formation for seals; light transmission through the ice, etc); 3) Role of freshwater on THC of the arctic ocean and it's connection to the Pacific and Atlantic; 4) Role of teleconnections in the Arctic to subarctic and temperate areas (e.g., role of longer open water in the fall on cyclogenesis and synoptic pattern development). (David Barber, University of Manitoba)	Ditto
15-1332	A	44	9			rewrite sentence (Peter Johnson, University of Ottawa)	Ditto
15-1333	A	44	9	44	11	I would suggest rewording to "… understanding and predictive capacity that restrict our ability to make more useful projections about the likely impacts of climate change in polar regions, and the importance of these changes for the global environment and Earth system." (Michael MacCracken, Climate Institute)	Ditto
15-1334	A	44	9		21	key uncertainties" quite incomplete... (Laurence C. Smith, University of California, Los Angeles (UCLA))	Yeah, Yeah
15-1335	A	44	13	44	20	add: Lack of ability to realistically predict extent and rates of permafrost degradation has serious imapcts on understanding water and carbon cycles and economic consequences. (Jerry Brown, International Permafrsot Association)	# This point comes up twice and should be considered
15-1336	A	44	13	44	14	Same comment as above in No.3 (Refer to Dendy Sloan and/or Pecher, or other references known to chapter authors). (David Malcolm, Arctic Energy Alliance)	Ditto
15-1337	A	44	13	44	14	As mentioned earlier - need to consider that release of carbon from gas hydrates in permafrost regions may take a long time to occur. (note also that hydrates are within and beneath arctic permafrost) (Sharon Smith, Geological Survey of Canada)	# This point comes up twice and should be considered
15-1338	A	44	17	44	19	the uncertanties in the current list are very different in level of detail. I would include the lack of supporting field data from many areas in the polar areas as beeing a major uncertainty. Remote sensing can offer a lot but the data has to be verified.	# This point comes up twice and should be considered

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						(Elisabeth Isaksson, Norwegian Polar Institute)	
15-1339	A	44	17	44	19	Need to also include the Greenland Ice Sheet here, and the ACIA report and subsequent efforts by ICARP and IPY have a lot of additional recommendations. (Michael MacCracken, Climate Institute)	# This point comes up twice and should be considered
15-1340	A	44	20	44	20	I suggest something go in here about the problem we have predicting future Antarctic temperature trends because of the lake of a dense long term climate record on this vast continent. We debate about the sign of the temperature trend in the past half century mainly because the record is spatially weak. (Peter Doran, University of Illinois at Chicago)	# This is a good point and should be dealt with in a catch-all statement about a lack of observations from polar (especially Antarctic) areas.
15-1341	A	44	20			Key Uncertainty: understanding of the potential for methane hydrate release from arctic permafrost, and high-latitude continental shelves, to cause a significant feedback to global climate (you have this one already, but I thought it bore repeating). (John Streicker, Yukon College)	Thanks for the suggestion
15-1342	A	44	20			Key Uncertainty: thermohaline drivers (John Streicker, Yukon College)	Thanks for the suggestion
15-1343	A	44	20			Key Uncertainty: measures of the effectiveness of adaptive strategies. (John Streicker, Yukon College)	Thanks for the suggestion
15-1344	A	44	20			Key Uncertainty: identification of crossover between adaptation and mitigation (John Streicker, Yukon College)	Thanks for the suggestion
15-1345	A	44	20			Key Uncertainty: how to engage Traditional Knowledge / Traditional Ecological Knowledge in a meaningful and respectful way. (John Streicker, Yukon College)	Thanks for the suggestion
15-1346	A	44	20			Key Uncertainty: Greenland ice-mass balance and where thresholds exist. (John Streicker, Yukon College)	# This point comes up twice and should be considered
15-1347	A	44	20			Key Uncertainty: considerations of new issues: sovereignty, security, human rights, identity, new levels of governance, etc. (John Streicker, Yukon College)	Thanks for the suggestion
15-1348	A	44	21			Other key uncertainties seem to me to include the net effect of climate change on greenhouse gas emissions from thawing permafrost, tundra and the Boreal forest. The response of the Greenland ice sheet must also be a significant uncertainty given our current inability to model how iceberg calving rates are likley to vary as the climate warms. (Martin Sharp, University of Alberta)	TRC TVC – will consider wording some of this # This point comes up twice and should be considered
15-	A	45	3	60	26	At this stage I have not checked the references with the text and vice-versa but I	Reference formats will be made consistent by

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1349						note that the listing of the journals is not consistent. Are the titles abreviated? (Robert Jefferies, University of Toronto)	TSU
15-1350	A	47	24	47	25	In line with the comment for p. 18, line 41, delete the unrefereed Cavalieri et al. 2004 bulletin note and instead reference the refereed Cavalieri et al. 2003 journal article (lines 21-23, p. 47). (Claire Parkinson, NASA Goddard Space Flight Center)	# Must do this
15-1351	A	50	31			Hinzman, Larry D. Neil D. Bettez, W. Robert Bolton, F. Stuart Chapin, Mark B. Dyurgerov, Chris L. Fastie, Brad Griffith, Robert D. Hollister, Allen Hope, Henry P. Huntington, Anne M. Jensen, Gensuo J. Jia, Torre Jorgenson, Douglas L. Kane, David R. Klein, Gary Kofinas, Amanda H. Lynch, Andrea H. Lloyd, A. David McGuire, Frederick E. Nelson, Matt Nolan, Walter C. Oechel, Thomas E. Osterkamp, Charles H. Racine, Vladimir E. Romanovsky, Robert S. Stone, Douglas A. Stow, Matthew Sturm, Craig E. Tweedie, George L. Vourlitis, Marilyn D. Walker, Donald A. Walker, Patrick J. Webber, Jeff Welker, Kevin S. Winker, Kenji Yoshikawa. 2005. Evidence and Implications of Recent Climate Change in Northern Alaska and Other Arctic Regions. Climatic Change. In Press. October 05 2005. (vol. 72, no. 3). (Larry Hinzman, University of Alaska Fairbanks)	TVC Maggan to get: done – will add reference
15-1352	A	50	36			Hinzman et al, 2005 (Larry Hinzman, University of Alaska Fairbanks)	?
15-1353	A					Congratulation also to this group of chapter 15 for a excellent piece of work. Looking the reference in this chapter, in the text and in the end, it is what I use to see in many scientific papers, so here format is somehow different from the other two chapter that I review (1 and 13), I guess that because the chapters will conform a book, references should the same for all. (Jorge Carrasco, Dirección Meteorológica de Chile)	Thanks Reference formats will be made consistent by the TSU
15-1354	A					GENERAL COMMENT ON SECTIONS 15.4.1.2 - 15.1.4.4. These three sections rely rather heavily on "In preparation" papers by Prowse and Reist. (Laurence C. Smith, University of California, Los Angeles (UCLA))	Unless accepted for publication the “in prep” papers will be excised